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REFINER
AND NATURAL GASOLINE MANUFACTURER
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The Look Box

The Oil Show at Tulsa

A PANORAMA of the most recent and up-to-date equipment methods and ideas in the various divisions of the petroleum industry will be presented to the oil men of the world when the International Petroleum Exposition at Tulsa, opens May 14.

For eight days key men of the production, pipe line, refining and marketing divisions of the petroleum industry, from 20 to 25 nations of the world, will visit the exposition and see, study and purchase their respective types of equipment. These men will attend banquets and meetings in their honor and they will take comprehensive tours through the exposition.

Special features of the exposition will include:

The new Hall of Science with models illustrative of every branch of the industry, including a working model refinery. The exhibits cost $350,000 to construct.

Events for "Old Timers" including awards to the "Grand Old Man of the Industry" and to the "Grand Old Man of Tulsa," and dedication of a memorial.

All-day safety contest.

Special events for the international delegates expected to attend from over 20 nations.

Young oil executives will be entertained by the Tulsa Junior Chamber of Commerce.

Special days will be devoted to purchasing agents, drilling contractors to those engaged in production, refining, pipe line, and marketing.

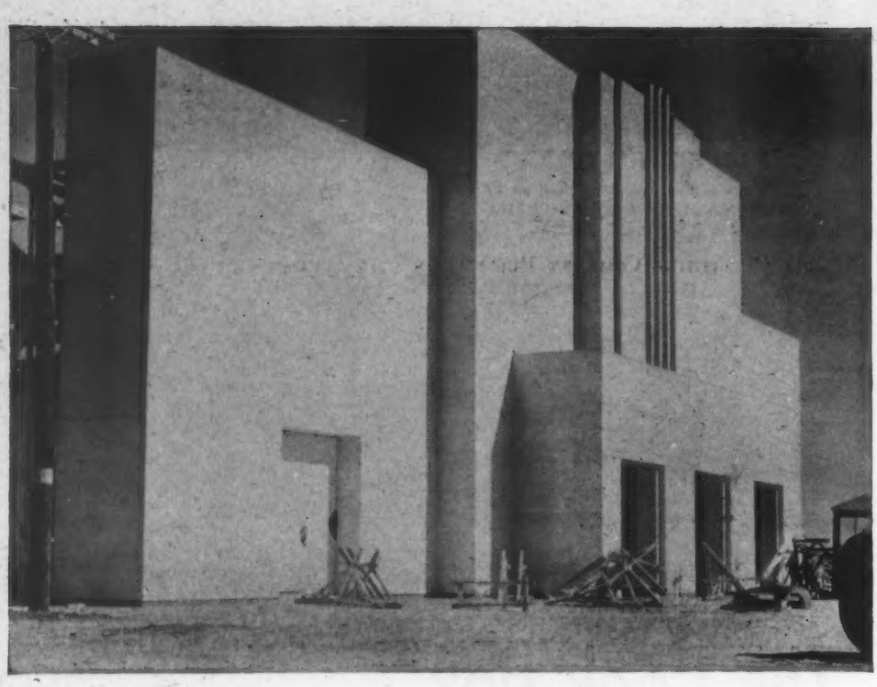
A press party will be held for leading oil editors of trade journals and newspapers over the nation, for the science editors of the Associated Press, International News Service, United Press, and the newsreels.

Special nationwide broadcasts direct from the grounds will be made by the radio chains.

HALL OF SCIENCE

One of the most popular exhibits will be the scientific and technical exhibits in the new Hall of Science, which will be under the direction of Dr. Gustav Egloff, director of research for Universal Oil Products Company, and chairman of the exposition scientific and technical committee. The exhibits depict through charts, dioramas and models how oil is found and refined and how the finished by-products are distributed.

The most interesting part of this scientific and technical exhibit is the 30-foot operating model of a modern petroleum refinery. This model shows all of the major operations from the fractional distillation of crude to the final treating of the five basic products, including the cracking process. The bubble towers, which are made of glass, show how the fractional distillation separates the crude into gasoline, kerosene, gas oil, lubricating oils and heavy residue oils. All of the operations of the refinery are carried on in glass tanks, pipe connections, retorts and bubble towers, while the intricate maze of pumps, pipes,



Face lifting for the enlarged Oklahoma building is typical of what the architects designed to assure eye harmony between the older buildings and the new construction at the plant of the International Petroleum Exposition.

motors and valves necessary to carry on the operations are concealed beneath the model. A recorded voice explains each operation as it occurs.

All of the methods of moving oil from producer to consumer, including pipe lines, tankers, tank cars, and trucks are shown in either working model or still model form. The various shapes and sizes of tanks necessary in the storage of oil is also a part of this display on transportation.

How oil is found, how test wells are shot, how drilling tools operate beneath the surface of the earth and what constitutes the difference between cable-tool and rotary drilling are demonstrated either through illuminated or working models in the exploration and drilling exhibits.

Recovery of oil by water flooding of fields, which have been depleted beyond the ordinary pumping stage, is one of the production displays. Other production displays include: the animated diorama of a typical American oil field, which shows the migratory nature of oil and illustrated the modern trend toward conservation by unit operation. A recorded voice, syncronized with the animation in the exhibit explains the actions as they occur; causes of crooked holes is demonstrated in a model as in many other types of troubles equipment and methods of the production division of the industry.

In the geological section are many exhibits of interest to the men connected with geological work, some of these are: an animated exhibit of a highly-folded over thrust, which is accompanied by a recorded voice; what appears to be a huge vari-colored cake, some of the layers of which fell in the process of baking, proves to be a model of an asymetrical anticline—a great block stimulating a cross section of the Grass Creek, Wyoming field, in which reverse dips are clearly shown; a model of a symetrical anticline; a salt dome; the structural rise of oil sand; relationship between oil, gas and water; the seismic reflection method; torsion balance; pendulum; induction and electrical resistivity; principles of the torsion balance and the magnotometer fossil remains and cores. All of these form a part of the exhibits devoted to geology.

Huge maps show the history of oil from the horse-drawn tank wagon of 1880 to the present insulated tank car and motorized marine and land equipment. Maps also show the gas, gasoline, and crude pipe lines and refineries of the world and of America.

The part that aerial photography plays in prospecting for oil is depicted in a diorama in which a model airplane flies back and forth with a light ray being projected over the landscape at intervals. This light shows the area which is being photographed as each picture is taken. A series of maps and aerial photographs supplement the display.

Oil seepage is shown in a diorama, a working model of a service station an operating anti-knock engine, a map howing 250 by-products of petroleum, treatises on propane, pentane and butane, a pipe line construction model; maps showing the geographical phases of the industry and maps of the economical aspects of the industry supplement the mammoth scientific exhibit.

The majority of the scientific and technical exhibits have been obtained for the duration of the exposition from the Museum of Science and Industry of Chicago and is the most complete exhibit of its kind ever before seen at an oil exposition. Other exhibits in the Hall of Science are furnished by various oil equipment firms.

NATURAL GASOLINE EXHIBITS

The exhibits relative to the natural gasoline division of the industry cover butane, propane; gas engines with mixing valves through which the pressure on the volume tank can be operated at any pressure up to six ounces through the use of the final low regulator; the latest types of storage tanks; refrigeration plant equipment; butane filling station; liquified gas bottling station; compressors for tank wagons for transportation of butane; flowmeters; latest types of pumps; pipe; stabilizers, reflux surge tanks, and many other types of equipment.

Vast strides have been accomplished in the increased usage of propane and butane. Through the use of butane as fuel around drilling rigs there has

W. G. SKELLY, ***President International Petroleum Exposition***

F. J. HINDERLITER, ***Vice President***

been developed a special carburetor for the power plants of the rigs. The use of butane for fuel in heating, where natural gas is not available is increasing in the nothern states and is becoming preferable to coal and other fuels.

Propane has made one outstanding development in its use for refrigeration purposes both domestically and commercially, this has also aided the industry itself in its own production.

Carbon black, which in the past has been very hard to ship, is now easily transported through the process of making it into pellets and shovelling it into tank cars for shipment.

REFINING EXHIBITS

As far as time has permitted the developments in the refining industry have taken great steps in the past two years. The chemist of various oil companies have been responsible for the improvement of refinery machinery and equipment in the past two years. The outstanding commercial processes which are now in use include: the use of solvent extractions; solvent de-waxing; polymerization plants and process; butane cracking plants; combination skim-

ALF. G. HEGGEM, ***Vice President***

C. H. PAPE, ***Treasurer***

ming and cracking units; sulphur removal from gasoline to improve lead susceptibility; Perco treating process; Lachman, Stratford, Hoover and Howard processes. All of these new processes have relative equipment, equipment which has been developed for their specific use, and which will be on display at the exposition.

Approximately 303 manufacturers have exhibits featuring refining equipment at the exposition and one exhibit building is being devoted to these exhibits.

With the improved exhibit facilities and construction of four new buildings by the exposition, more than 600 firms have contracted for exhibit space at the show. Due to the increasing interest of members of the refining industry and the greater amount of improvements being made in equipment of interest to the members the space allocated this division has been greatly increased.

A survey of equipment to be seen at the show, according to a report by the refining committee, includes the latest methods, machines and equipment used in the modern refinery.

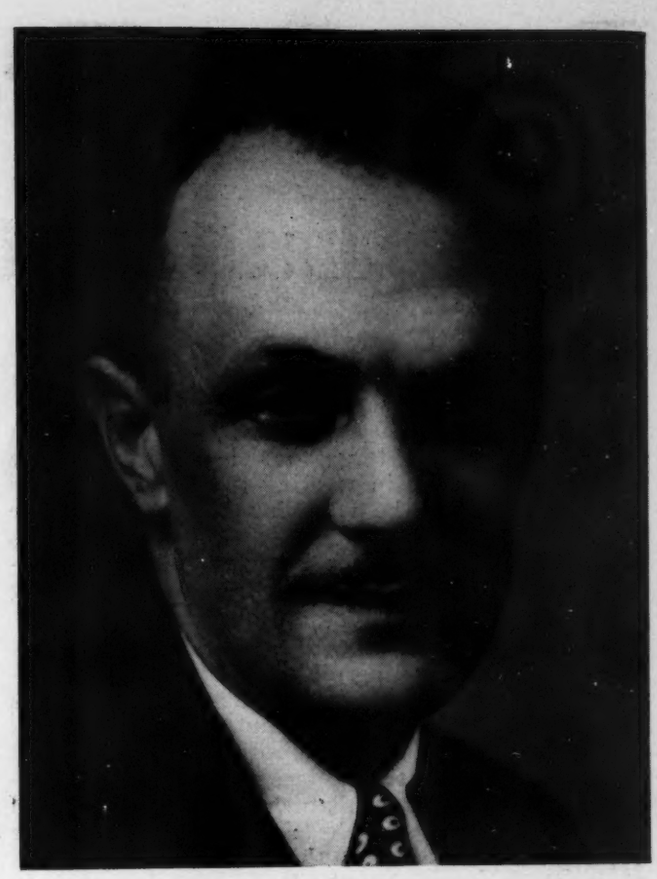
The displays include such equipment as: refractory cement for laying fire brick to resist destructive slagging action and to withstand refinery acid sludge, plastic super-refractory surfacing mortar, which is applied over the face of fire brick to prevent erosion due to slag; protective coatings to protect refinery equipment against corrosion; joint-sealing compound for making leakproof joints. Still, steam, air, sandblast and gasoline loading rack, hose; red lead in cans, ready mixed for immediate use; dial and recording thermometers, controllers, all types for temperature, pressure, liquid-level, flow; oil testing instruments for laboratory and plant use. Flexible couplings, safety tools, and corrosion-resistant valves and fittings; roller chains, sprockets, couplings for hot-oil pump drives, and generator drives, steel gate valves, designed for high-speed opening and closing; lubricated plug valves for refinery service, including three-way and four-way patterns.

Making of thermometers is to be displayed with actual skilled workmen to show how thermometer tubes are made that use mercury bulb and by reflection shows a bright red column; mechanical power transmissions; compressor used for vapor recovery, propane, refrigeration and hydrogenation; pipe coupling castings, made of various steel alloys and stainless steel; plain carbon and various alloy steel tubes for refineries; patented designs of pouring and dispensing openings, seamless cracking still tubes; flue-cleaning hose, acid gloves; braded wire rope slings used in the handling and installation of refinery equipment; fabricated structural steel for buildings, bridges, supports; bubble caps and trays; automatic inter-communication telephone equipment; ball bearings; nut runners, portable electric hammers; centrifugal hot-oil pumps; lubricated plug valves; explosion-proof motors and controls, mechanical drive steam turbine; hand portable testing pump of 6000 pounds for testing valves, fittings, tanks and pressure vessels.

Condenser tubes, heat exchanger tubes, complete oiling and filtering systems for pumps; refining service gauges, steam gauges, gauges suitable for application to tar, and high temperatures; high speed test tube centrifuge; explosion-proof lighting equipment; septic tanks, vitrified clay sewer pipe; refractories, silent and roller-chain drives, power transmission

equipment; high-pressure vessels for modern cracking processes of all sizes and wall thicknesses; complete line of laboratory materials; recording and controlling equipment; electric air hose; tank gauge masks, oxygen breathing apparatus, combustible gas indicators, meters; asbestos sheets for industrial roofing and siding; one and a half ton safety pull ratchet lever hoist for pulling super heater exchange bundles tubes, and stills, and general maintenance around plant.

Tube cleaners for curved tubes and lines, heat exchangers, boiler, tubes; complete line of tank fittings including vent hatches, swing line equipment, automatic tank gauges, equipment for high pressure storage, bubble tower trays and bell caps, still safety valves and look boxes; antioxidants used to prevent gum formation in cracked gasoline, gasoline colors; large vertical heavy duty agitator drives, combination worm and helical gears with very high ratios maintaining high efficiency; automatic installations used in connection with canning motor oil; improved materials and methods for removal of carbonized oil from oil coolers, preheaters and similar exchanger equipment to restore normal heat transfer; recirculating and tank immersion methods make possible the removal of accumulations which have resulted from high temperatures and which formerly resisted any but mechanical cleaning methods; a combustion safe-guard for gas burners designed to shut off the gas instantly in case of flame failure. Electric flow meter, for making a record of the flow of liquid through a pipe line at some distance away from the point of the measurement and totalizing this flow by means of an electric integrator; a new high pressure rotary pump which meets the demand of oil field engineers and superintendent for a pump with high efficiency over a wide range of speeds and pressures.



H. R. POWERS, *Secretary*

SAFETY EXHIBITS AND CONTEST

The latest methods and appliances used by oil companies in their fight to reduce fatal and crippling accidents to their employees will be a feature.

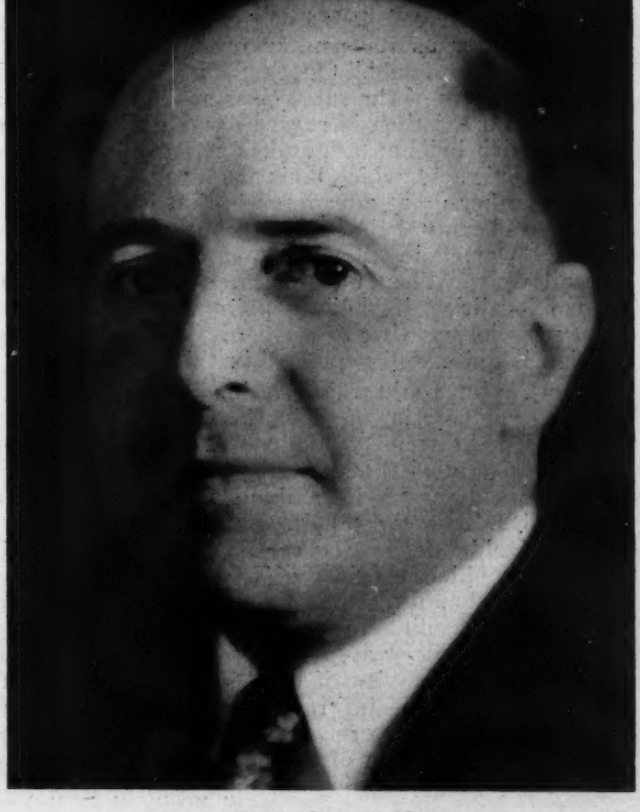
Friday, May 20, will be Safety Day. This day is set aside so that the visitor to the oil show can stop and appreciate the troubles and difficulties that beset the men of the industry who devote their every working hour to improve and clarify the rules, ideas and equipment for making every worker safe from injury of any sort. This day will see the safety contest, in which safety teams from practically every major oil company of the country will compete in honors for efficiency, knowledge and speed in caring for the injured. J. D. McCamey, director of safety for Carter Oil Company, Tulsa, and chairman of the exposition safety committee, said that the largest display and exhibition of safety teams, equipment and practices ever seen at an oil show would be presented.

INTERNATIONAL DELEGATES

The international aspects are brighter for the tenth exposition than they have been for any previous year. From 20 to 25 nations will send delegates in order that they may know more about the latest equipment, ideas and methods of the petroleum industry.

James H. Gardner, president of Gardner Petroleum Corporation, and chairman of the International Delegates Committee, has announced that the international delegates to the exposition would be taken on tours throughout the main points of interest in the

(*Continued on page 61*)



W. B. WAY, *General Manager*

Propane Treatment *of* Lubricating Oil Stocks*

M. B. COOKE and EARL PETTY,
Alco Products, Division of American Locomotive Company, and

PAUL BARTON,
Sun Oil Company

THE treatment of petroleum and its intermediate products for the purpose of obtaining a useful article of commerce is a very old subject but one which continually is the target for technologists. The amount of interest in treating petroleum fractions is exemplified by the voluminous patent literature as well as books devoted to the subject. This is indeed a healthy condition for where there is dissatisfaction there is at least the hope that something constructive will result.

It is unnecessary to go over the developments of distillation and lubricating oil manufacture by conventional methods in view of the many excellent sources of these data. It may be opportune, however, to look back a few years for the inspiration of the work and processes which is the subject of our immediate interest, i.e., "propane treatment of lubricating oil stocks." A survey of the literature reveals some rather interesting work on the subject of solvents and their effects upon mineral oils. In 1867, less than 10 years after Drake's oil discovery at Oil Creek, Pennsylvania, Vander Weyde[1], a physician in Philadelphia, took out a patent entitled "Improvement in the Manufacture of Liquids for Making Ice and for Other Purposes." He separated a liquid which was called in those days "the hydride of propyle" but which he preferred to name "chimogene, meaning cold-generator as its spontaneous evaporation produces an intense cold." Quoting further, "this liquid, with the others of the same class spoken of, fills the gap thus far existing, in regard to volatility, between ether, which boils at 90°, and liquefied nitrous oxide and carbonic acid, which boils at 130° and 112° below zero—another great advantage is that it can be procured so cheaply, being nothing but a material now entirely wasted in all petroleum distilleries and at the oil wells. When manufactured at the last-mentioned localities, its boiling point may be obtained almost as low as that of ammonia, etc." Autorefrigeration is quite well explained in this early work.

Another interesting dissertation on the use of petroleum solvents is found in Gurwitsch[2]. He apparently used the term "cymogene" as did Dr. Vander Weyde and called the higher-boiling fractions "rhigolene." He describes ice-making and the use of the low molecular weight hydrocarbon gases as anesthetics. Holde[3] discloses a refining process for lubricating oil which consists of treating residua from distillation, having a specific gravity greater than 0.97 "with gasoline or other petroleum distillates having a specific gravity of less than 0.70." Since propane has a gravity of 0.50, it appears to be included in Holde's claim from which the above quotation is made. The term petroleum ether has been used to cover solvents of wide boiling ranges and for this reason it appears opportune to quote a patent[4] issued in Poland in December, 1920, entitled "Method for the Separation of Asphaltic Substances from Crudes or Crude Oil Products." "It is well known that the solubility of the asphaltic bodies which are found in most crude oils and crude oil products decreases if we lower the boiling limits of the gasoline used for precipitation of the asphaltic bodies and, at the same time, its percentage of aromatic hydrocarbons".[5] Quoting further, "The present invention is based on the knowledge that the precipitation of asphaltic substances by means of a mixture of hydrocarbons originating from natural gas which is stable in the liquefied condition at room temperature in the case of the application of over-pressure only, is not only possible, but that we are able, by means of such a mixture to precipitate a considerably higher amount of asphaltic bodies than when using lowest boiling point gasoline or petroleum ether fractions. Such a hydrocarbon mixture may be obtained either directly from gasoline containing natural gases or by distillation of commercial gasoline prepared from natural gas."

The data given in Example No. 1 in the patent are shown in Figure I.

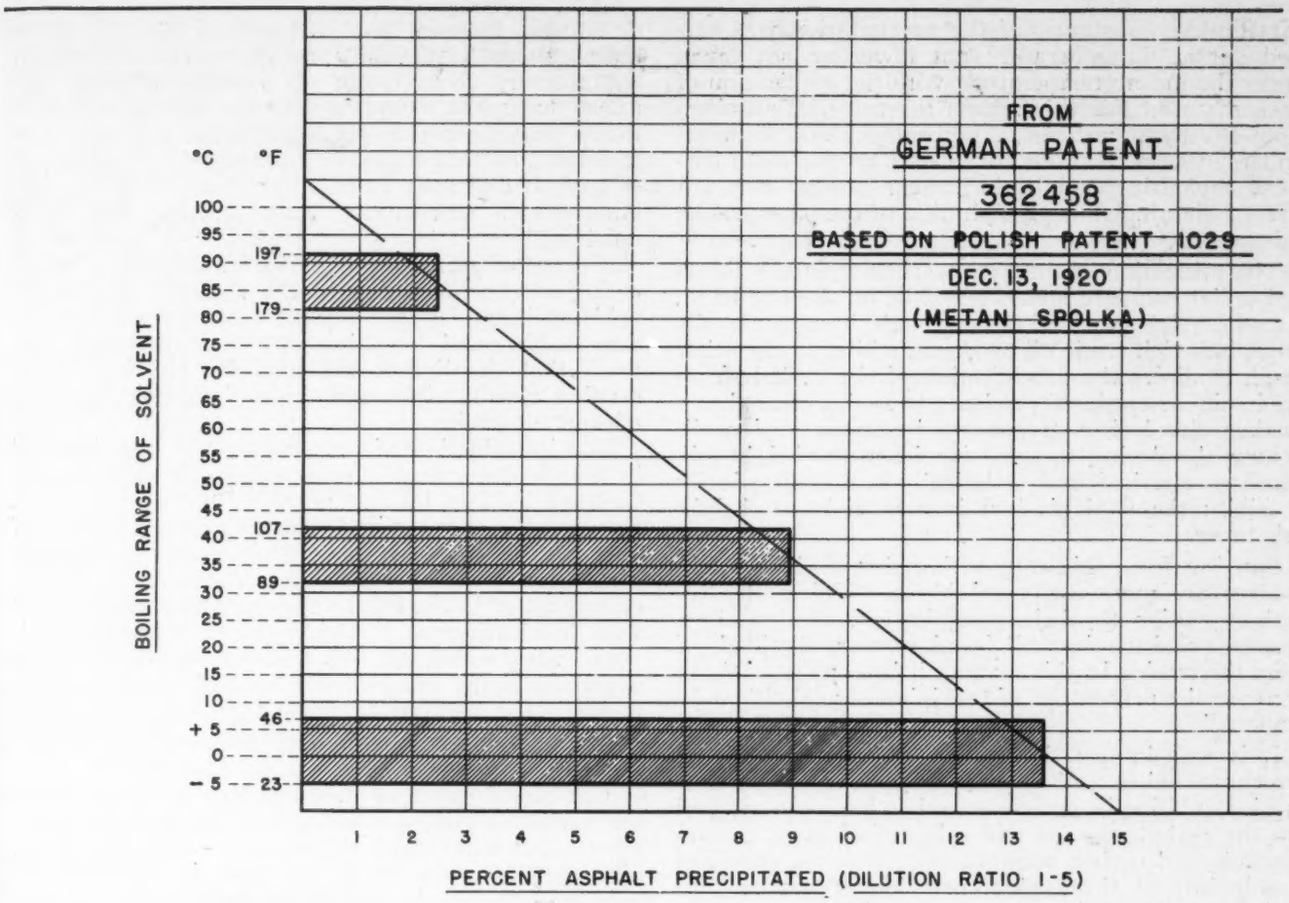
(a) From the natural bituminous material originating from Boryslav crude oil, the asphaltic bodies were precipitated at a ratio of 1 to 5 by means of a gasoline boiling within a range of 179.6°F. to 197.6°F. The amount of asphaltic bodies precipitated was 2.6 percent.

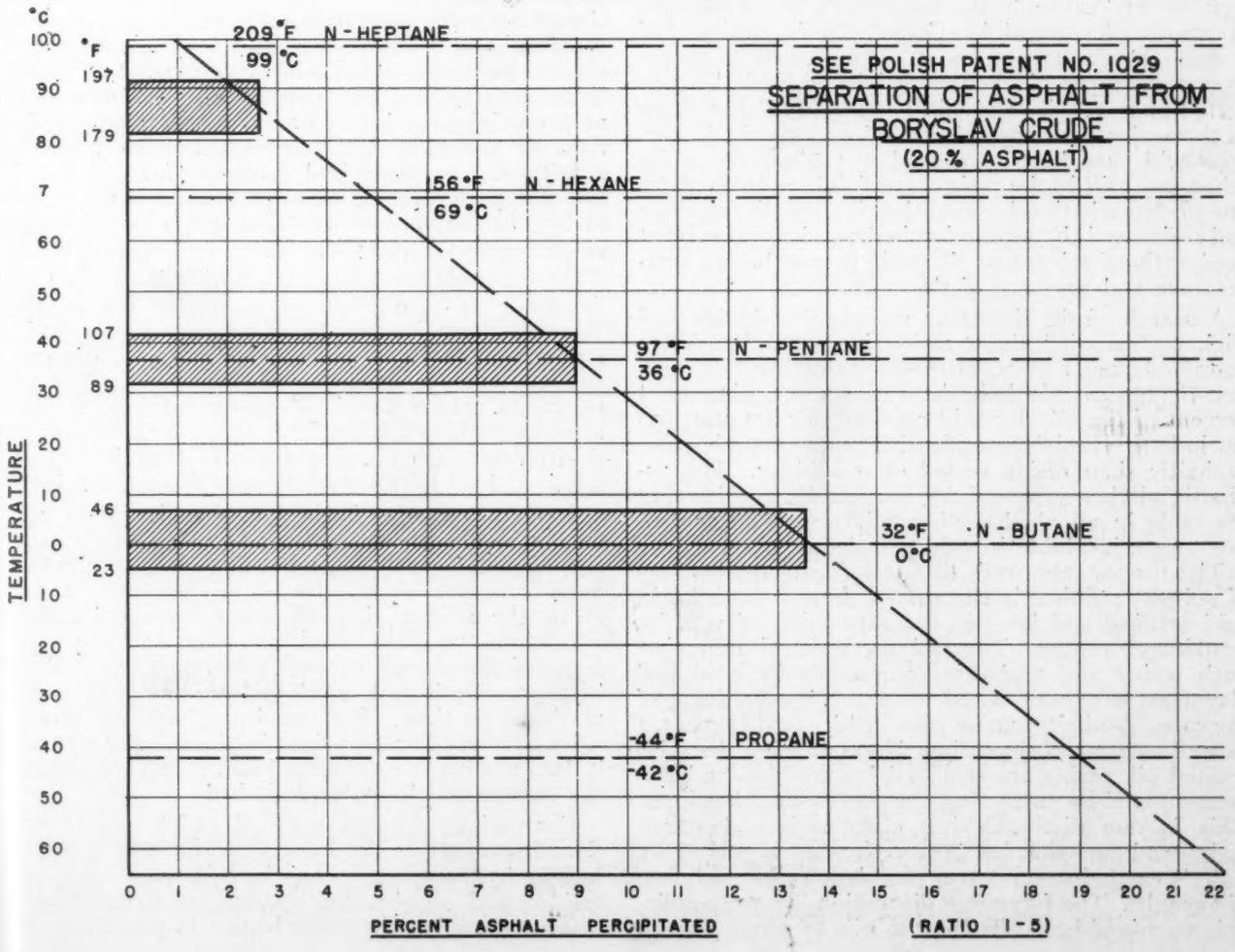
(b) From the same bituminous material the asphaltic bodies were precipitated on dilution in the ratio 1 to 5 by means of a petroleum ether boiling between 32 and 42°C. (89.6 and 107.6°F.) The amount of the asphalt precipitated was 8.7 percent.

(c) From the same bituminous material the asphaltic substances were then precipitated with the application of pressure by means of a dilution in the ratio of 1 to 5 with the aid of a mixture of hydrocarbons liquefied under pressure and obtained by redistillation of Boryslav gasoline, the boiling point of which was within -5 to 8°C. (23.0 to 46.4°F.) The amount of the asphalt precipitated rose to 13.4 percent.

In the case of this method, it was found that the asphalt precipitated (Example 1C) was free from

*Presented before Thirty-Fifth Semi-Annual Meeting of the National Petroleum Association, Cleveland, Ohio, April 13, 1938.


FROM
GERMAN PATENT
362458
BASED ON POLISH PATENT 1029
DEC. 13, 1920
(METAN SPOLKA)
°C °F
BOILING RANGE OF SOLVENT
100
95
90 197
85
80 179
75
70
65
60
55
50
45
40 107
35
30 89
25
20
15
10
+5 46
0
−5 23
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
PERCENT ASPHALT PRECIPITATED (DILUTION RATIO 1-5)


SEE POLISH PATENT NO. 1029
SEPARATION OF ASPHALT FROM
BORYSLAV CRUDE
(20 % ASPHALT)
209 °F N - HEPTANE
99 °C
156 °F N - HEXANE
69 °C
97 °F N - PENTANE
36 °C
32 °F N - BUTANE
0 °C
-44 °F PROPANE
-42 °C
°C
°F
TEMPERATURE
100 90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60
197 179 107 89 46 23
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
PERCENT ASPHALT PERCIPITATED (RATIO 1-5)

paraffin-like substances if the precipitation was carried out at a temperature not lower or not much lower than room temperature, with the application of overpressure. For this reason the material obtained from the hydrocarbons of natural gas and liquefied under pressure may be considered as the most efficient asphaltic precipitating agent which does not effect a simultaneous precipitation of the paraffin-like substances.

The utilization of the hydrocarbon mixtures liquefied under pressure makes possible, on the one hand, a commercial preparation of asphalt from crude oils or asphalt-rich crude oil products, while, on the other hand, it allows the precipitation of the asphalt from crude oils or crude oil products to such extent that a further decoloring treatment by means of well-known decoloring agents, for instance, bright oil, vaseline, etc. is found technically and economically possible; the final product is a bituminous, bright substance.

Starting from this supposition that asphaltic substances are more easily soluble in "higher" hydrocarbons, prior to their precipitation, the gasoline, kerosene and medium oil fractions were distilled off from the crude. In this manner it became possible to increase the percentage of precipitated asphaltic substances."

It is well known that as the resins in petroleum are converted to asphaltenes (by heat or otherwise), the insolubility in petroleum ether becomes marked but the asphaltenes are still soluble in benzol, carbon bisulfide and carbon tetrachloride. From a chemical standpoint, as the asphaltenes dehydrogenate into carbenes and carboids, the solubility in these solvents decreases. As stated by Gruse[6], "it is obvious, of course, that in a complex substance such as petroleum some types of compounds will probably be converted more readily and will be carried farther along in the series than the others. Thus some hydrocarbons will have been converted to asphaltenes while others are still in the resin stage." There is no sharp line of demarkation between lubricating oil fractions and resins and the separation is dependent on solvent used, ratio of solvent to oil (weight or volume), temperature and pressure of the operation.

A search of the literature reveals that Holde and Eichman[7] studied these resins in 1906-1907. They extracted resins from Russian lubricating oils with hot 70 percent alcohol, the resins amounting to 4 percent of the oil. By acid refining this amount was cut in half. Holde's classification of compounds more asphaltic than resins rested on solubility. The asphaltic pitches were soluble in petroleum ether but insoluble in an alcohol-ether mixture. The asphaltines were insoluble in cold petroleum ether.

The nearest approach to our modern applications of solvent refining is the use of diluent naphtha in cold settling and later in the separation of wax by centrifugal means. The old methods of removing both resins and asphaltic compounds by acid and clay treatment was based upon the known facts of the case. Asphalts can be removed by acid treatment as well as some of the resins. Upon filtering the acid-treated oil, resins are removed by the clay and can be recovered by extracting the clay with chloroform. This is one distinguishing characteristic between resins and asphalts, i. e., the resins are absorbed by fuller's earth from a warm petroleum ether solution of asphalt[8]. The foregoing discussion is more applicable to mixed-base oils than to oils of Pennsylvania or paraffin base in that in the latter there is not a large amount of asphalt, and this permits lubricant manufacture from crude oil residue whereas the mixed base and asphaltic oils are first distilled to throw out the major portions of the asphalt. The fact remains that solvents probably do a better job of asphalt and resin removal than did the old combination of distillation, acid treating and clay finishing.

The use of petroleum naphtha for dilution of lubricating stocks for aiding in the removal of wax by cold settling was the logical step toward solvent deasphalting and dewaxing. It was learned from this work .that the lighter the naphtha, the better the settling results. The same was found in the centrifugal dewaxing.

The introduction of propane was a step forward in that it does the job more efficiently than do the higher homologs butane, pentane, and hexane. It is then quite in order to find that the first application of propane was to throw down asphalt as a precipitate. Petroleum ether and propane, therefore, are more closely allied in the results they produce when mixed with lubricating oil stocks than any other two solvents with which we are familiar. They differ in degree as to the results accomplished. An important result is the separation of the higher lube fractions which cannot be obtained by distillation from asphalt by commercial means.

The introduction of propane into the lubricating oil manufacturing processes has resulted in other advantages with which the most of us are cognizant. The use of the diluent, in this case, as the refrigeration medium, needs no introduction. Suffice to say that the present competitive schemes or processes for the dewaxing of lubricating oil stocks revolves about this multiple use of the solvent, i. e., (1) as a diluent to reduce viscosity and (2) as a refrigerant and (3) as a precipitating agent or (4) as various combinations of the three items mentioned under *controlled conditions*. The recognized processes for propane deasphalting, deresining, and dewaxing appear to differ mainly in the autorefrigeration usage and the steps employed in the process.

One advantage of propane dilution is the fact that dewaxing is readily accomplished in its solution. Another attractive feature of propane is that it is a refrigerant and can be liquefied, cooled, expanded and will produce refrigeration down to very low temperatures. Since it can be evaporated from its solutions to produce refrigeration, there is no loss of heat transfer through metallic walls of heat interchangers, i. e., heat is removed directly from the solution.

Last but not least is the fact that the larger refiners, as a rule, are natural producers of propane and they do not have to depend upon or pay profits to an outside source of the diluent-refrigerant. In some cases, the refiner, through other unrelated refining operations, produces liquid propane and can regain some of the energy expended in rendering it liquid, by expanding it to do work and produce refrigeration at the same time. The smaller refiner can buy the solvent at reasonable prices in the open market and it does not become a contaminant in his vapor-recovery system and losses go into fuel.

For various reasons, some of which will be mentioned, propane is the most desirable low molecular weight hydrocarbon to use in this work. Asphaltic residua and wax-bearing residua are handled in the same manner but the latter begins to precipitate wax

from the propane-oil phase upon mixing with propane, generally at room temperature, depending upon the solvent ratio and the wax content. As the temperature is lowered, additional quantities of wax precipitate. The commercial criterion is that temperature at which the pour and cloud test specifications of the finished oil are satisfied. Another reason for propane's popularity for this work is because it is available in most locations and it is of no use for motor fuel. Butane, while it has quite satisfactory solvent qualities, is utilized both in motor fuel and in other industries so that the material is too valuable to use as a simple solvent.

Going to the lower molecular weight petroleum gases, ethane, for example, exerts too high a vapor pressure to make its use practicable in reasonably-priced equipment. It so happens that the atmospheric boiling point of propane is as low as it is necessary to go to accomplish the results desired. It is not surprising therefore to find that propane has forged ahead during the last few years to a position where it is a serious competitor to accepted refining methods and materials.

There has been considerable discussion of propane treating during the past few years. The more important references are listed in the bibliography for convenience.

The process which we will now describe differs from those described in the literature in two essential respects; (1) continuous chilling as opposed to batch chilling and (2) simultaneous deasphalting, deresining, and dewaxing are accomplished.

The Sun-Alco process uses an optimum proportion of propane to obtain the final result on the particular stock in question to reduce its viscosity and employs indirect refrigeration on the mixture to a point where approximately 90 percent of the refrigeration duty has been accomplished, only evaporating propane to attain the remaining 10 percent of refrigeration. In this process, propane is auto-refrigerated alone and the cold propane is injected at the 90 percent point of refrigeration. The reason we have maintained our indirect chilling process is to be found if one studies critically the crystallization of paraffin waxes and the effect of extraneous or other compounds. The inter-effect of proportions of propane oil and wax in the cooling stage, if properly controlled, results in great speed of chilling without the formation of minute crystals which filter poorly. The continuous process is subject to strict control. The range of control is such that in some combinations results are obtained which are impossible in batch systems.

The success of propane dewaxing depends upon the rate of wax separation, so much so that we are not interested in autorefrigeration exclusively as a chilling means. This is due to inherent limitations in the autorefrigeration process.

The reasons for the development of different systems of propane treatment of lubricating stocks are probably best understood if we consider the two fundamental types of stocks upon which the greater proportion of propane treatment is bound to be associated. These two types are represented by Pennsylvania and by Mid-Continent lubricating stocks, the latter including any naphthenic stocks carrying wax. With the two main stocks defined, it is not unusual to have groups of technologists working on separate processes. This is actually the case.

DEWAXING DISTILLATES VS. RESIDUUM

The two problems in connection with the two representative types of crudes, Pennsylvania and Mid-Continent are essentially problems inherent in treating of residua and those of treating distillates. The Mid-Continent problem is one of working with topped crude as raw material whereas the Pennsylvania problem involves the treatment of Pennsylvania wax distillate amounting to 12-15 percent of the crude as well as Pennsylvania steam-refined stock amounting to 18-20 percent of the crude, with the possible alternate of handling a 38 percent reduced Pennsylvania crude.

The gains from the utilization of propane in treating Pennsylvania oils are mainly due to larger yields of lube oil and the enhanced decolorization resulting in lower filter costs. If this cannot be done, the attraction for propane is limited. The Mid-Continent operation, however, is one where vacuum distillation for removal of asphalt is replaced by propane treatment, eliminating to a large extent the decolorizing by acid and replacing it by solvent treating such as furfural, phenol, duo sol, or nitrobenzene or sulfur dioxide, etc. At the same time, possibilities of new products obtainable by this process are opened up.

The flow diagram Figure 2 illustrates the main operations and principal vessels.

As an example of our operation on topped crude, we make a low ratio blend of oil and propane (for example, one to one) which is pumped through a mixing device. The blend is passed through a scraped-surface type of exchanger such as a conventional wax distillate type double-pipe chiller. The mixture is chilled to minus 25°F. or lower and is then mixed with additional propane, which has been chilled to minus 45°F. to bring the ratio to 5 parts of propane to 1 part of oil. The chilled mixture is then filtered. The asphalt acts as a filter aid and high rates are obtained.

Tables 1, 2 and 3 give the distillation break-up on (1) 36 percent topped Mid-Continent crude, (2) dewaxed, deasphalted Mid-Continent crude, and (3) filter residue.

These tables show that:

1. The topped crude or residuum carries all the

TABLE 1

Mid-Continent Topped Crude — 36%

CUT	Gravity	Flash	Fire	VISCOSITY 100	130	160	210	P.T.	Color	°F. Bulb M.P.	MEK Percent Par.	M.P. of Par.	Percent Crude
10 percent	33.8	240	260	40	37*	.....	.....	+ 30	1+	Liquid	1.0	.....	3.6
20 percent	30.8	335	360	56	45*	.....	.....	+ 60	1½−	Liquid	12.7	108–110	3.6
30 percent	28.8	355	420	85	59	.....	39*	+ 85	1¾	80–	17.4	116–118	3.6
40 percent	27.1	405	490	166*	93	.....	45	+105	2¾	96– 98	19.5	130–132	3.6
50 percent	25.7	425	510	253*	...	79	50	+115	3¼	104–106	19.1	136–138	3.6
64.5 percent	24.1	485	565	590*	...	133	66	++120	4+	116–118	19.4	140–142	5.22
Btms	13.7	615	695	...	...	5176	1130	+110	...	.....	...	.....	12.78
Chg	23.1	235	400	...	245	132	68	+105	...	104–106	17.0	132–134	36.00

Cast and Color—Good.

* Extrapolated from the A. S. T. M. Chart.

TABLE 2

Vacuum Distillation and Test Data on Dewaxed-Deasphalted Mid-Continent Crude

CUT	Gravity	Flash	Fire	VISCOSITY 100	130	160	210	P.T.	Color	ASTM Cloud	Oxid.	Con. Carb.	Percent Yield	Percent Crude
10 percent.	33.7	220	245	41	37	....	....	—5	1—	+ 4	...	...	5.38	1.937
20 percent.	30.3	300	330	40	42	....	....	0	1+	+18	...	...	5.38	1.937
30 percent.	26.8	340	390	77	54	....	37*	—25	1½+	+14	...	...	5.38	1.937
40 percent.	25.0	385	440	157	86*	....	42	—10	2	+ 8	59.6	0.01	5.38	1.937
50 percent.	23.5	430	480	323	147*	....	50	—20	2½*	— 4	65.6	0.02	5.38	1.937
60 percent.	†22.1	450	530	784	300*	....	65	—25	3¾	—18	64.4	0.14	5.38	1.937
70 percent.	21.3	485	560	1315*	453	....	78*	—20	4¼	—22	54.0	0.46	5.38	1.937
75 percent.	20.6	490	580	2700*	810*	....	105	— 5	5½	.....	.....	... Ash	2.69	0.969
Btms.....	16.1	605	680	....	....	3571	1087	+60	...	.....	...	Trace	13.45	4.842
Chg.....	22.9	310	355	428	188	....	56	0	...	....	...	...	53.8	19.370

Cast and Color—good. * Extrapolated from the A.S.T.M. Chart. † Extrapolated from the V.G.C. Chart.

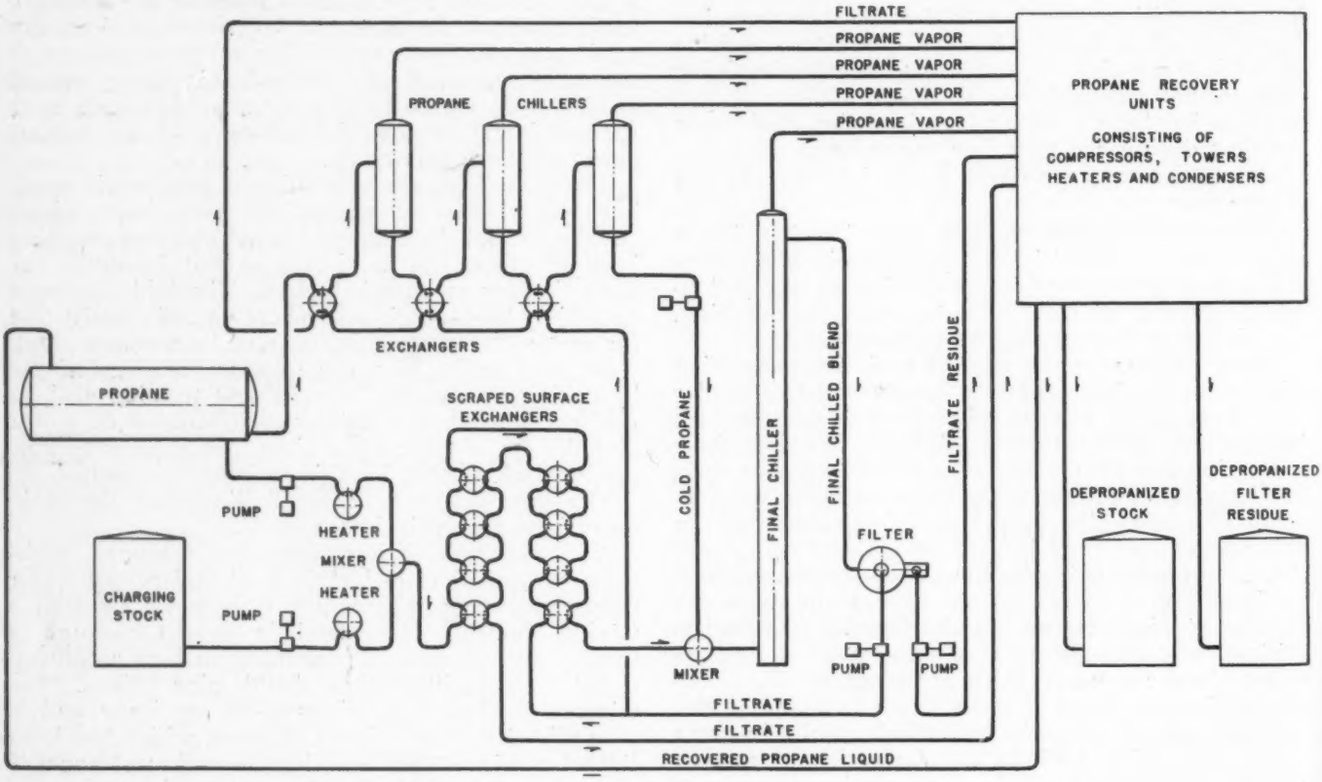


FIGURE 2

Flow diagram, Sun-Alco Propane Dewaxing Process

TABLE 3

Vacuum Distillation and Test Data on Filter Residue

CUT	Gravity	Flash	Fire	VISCOSITY 100	130	160	210	P.T.	°F. Bulb M.P.	Percent Par. MEK	M.P. of Par.	Percent Charge
1.....	25.5	275	300	45	..	...	...	+65	.....	27.5	102–104	10.0
Btms. No. 1.....	...	...	...	..	..	...	...	.....	132–134	40.1	134–136	10.0
2.....	34.6	335	405	..	49	...	36	+105	94– 96	45.7	116–118	8.0
Btms. No. 2.....	...	...	...	..	..	...	...	.....	138–140	39.9	138–140	10.0
3.....	32.9	395	455	...	59	...	39	+115	108–110	51.0	126–128	6.2
Btms. No. 3.....	...	...	...	..	..	...	...	.....	144–146	37.0	140–142	10.0
4.....	...	435	495	..	..	...	42.5	++120	116–118	50.3	132–134	4.6
Btms. No. 4.....	...	...	...	..	..	...	...	.....	150–152	35.8	146–148	10.0
5.....	...	445	530	..	..	...	48	++120	124–126	50.2	138–140	3.1
Btms. No. 5.....	...	...	...	..	..	...	...	.....	154–156	33.9	146–148	10.0
Chg.....	22.0	360	450	..	..	246	111	.....	.....	...	.....	...

The bottom cuts were run by the MEK method of analysis.

Total Distilled..... 31.9 percent
Total Bottoms..... 50.0 percent
Bottoms Left..... 18.1 percent

non-viscous and viscous neutral from Mid-Continent crude and the overhead fractions are good stable colors, show a good oxidation, and low carbon residue.

2. A large quantity of light colors, sweatable-waxes can be distilled off overhead (over 50 percent).

3. It does not degrade the oils to redistill them after propane dewaxing. The dewaxed, deasphalted oil can be either solvent treated before fractionating, or individual cuts may be solvent refined, thus producing the maximum percent of light-body, light-color oils at the lowest treating, distilling, and filtering costs.

From the average lubricating oil plant which would be built up around propane dewaxing and deresining, there is usually no possible commercial disposal of all the petrolatum to refined waxes. Some of it must be burned or cracked. It appears that the most economical disposal of the wax and asphaltic material is in one product and then by-product finishing equipment can be installed for making whatever amount is required into finished waxes or finished asphalts. The concentration of waxes in the filter residue makes a great difference in its distillation characteristics.

Particular attention is invited to the fact that this process is continuous and there are no surge tanks for blend receiving, filter charge or asphalt settling. The process is a tubular system through the chilling up to the filter supply.

The simple flow of the process in addition to the high rate of separation of wax and cake more than justify the residuum process in comparison to a distillate system or a deasphalted residuum system for mixed-base Mid-Continent crudes.

PENNSYLVANIA LUBRICATING STOCK OPERATION

The application of the Sun-Alco Propane process to Pennsylvania-type oils differs from the Mid-Continent operation in that either a Pennsylvania long residuum amounting to 38 percent of the crude oil can be used as charge stock or a wax distillate may be taken from a fractionating tower and a steam-refined cylinder stock made as a residue. In the latter case it is necessary to either operate on wax distillate and then on cylinder stock or build a plant with parallel flow of the two charge stocks. The preferable operation would be the latter and this will therefore be discussed in some detail. Pennsylvania crude is fractionated into a wax distillate containing the neutrals and the bottoms consisting of steam-refined stock which run to separate storage tanks. If the conventional pressable wax distillate is carefully fractionated into 10 percent cuts, the characteristics would be somewhat as in Table 4.

TABLE 4

	A.P.I. Grav.	Sus. Vis. @ 100-130°F.		M.P.	Mek. % Par.	MP of Par
1-10 percent	42	35	...	....	0.8	.....
2-20 percent	41	40	...	....	3.2	84 -86°F.
3-30 percent	38	47	...	....	10.1	92- 94°F.
4-40 percent	36.5	55	...	....	14.1	96- 98°F.
5-50 percent	35.4	**60**	...	....	**16.2**	**106–108°F.**
6-60 percent	34.3	81	...	74°F.	16.6	114-116°F.
7-70 percent	33.1	99	...	84°F.	16.8	122–124°F.
8-80 percent	32.3	..	79	90°F.	16.6	124- 26°F.
9-90 percent	30	..	105	96°F.	15.7	130- 32°F.
Res.	29	..	199	96°F.	14.5	130- 32°F.
Charge	35.1	70	...	....	11.9	.....
Combined 1st 50%	38.4	44	...	....	8.7	98-100°F.
Combined 2nd 50%	32.1	..	91	90°F.	15.8	120-122°F.

The material indicated above can be run as a whole fraction but is preferably cut at the 40 percent point since it is not highly desirable to propane treat materials of low viscosity containing waxes of low melting points such as are contained in the first four 10 percent cuts. In other words, the distillate we prefer to treat shows approximately a Saybolt viscosity of 100 at 100°F. instead of the conventional 70 Saybolt at 100°F.

This wax distillate is charged to conventional wax distillate type chillers with a propane dilution of only 10-20 percent (volume). Upon leaving the exchangers the wax distillate is diluted to 80 percent propane by the addition of cold propane. The propane is chilled simultaneously in a separate chilling system, utilizing the cold filtrate for exchange on the scraped-surface chillers of the original blend and then against the propane being chilled for cold blending.

When operating on Pennsylvania steam-refined stock, we blend propane with stock and chill it by indirect means. Additional cold propane is then added to the optimum filtering dilution. The steam-refined stock obtained by this method from Bradford crude shows about 3000 optical density whereas the bright stock obtained is better than 1000 optical density. The filter residue from this operation can be distilled, taking overhead two 10 percent fractions, i. e., 20 percent overhead of light-colored wax showing a melting point between 130-138°F. The residue of dark petrolatum carries the coloring material normally lost in the filtration process.

The Table 5 gives the O.D. of each cut representing a yield of 100 gallons of bright stock or cylinder stock finished to this color.

TABLE 5

	Dewaxed Deresined	Dewaxed Deresined	Dewaxed Deresined	Charge Stock Steam Cyl. Stock
Cut No.	1100 OD*	925 OD*	1260 OD*	3020 OD*
1	157 OD	121 OD	119 OD	269 OD
2	284 OD	298 OD	241 OD	540 OD
3	351 OD	440 OD	376 OD	830 OD
4	578 OD	535 OD	457 OD	995 OD
5	615 OD	657 OD	617 OD	1050 OD

* Color before filtering in optical density.

SUMMARY

The Sun-Alco Process described has the following features:

1. Very accurate control of the blend of propane and oil, through a wide range of dilution.

2. Indirect chilling through recovered refrigeration carrying the initial blend to within 20-30°F. of filtering temperature.

3. Accurate control of filtering dilution.

4. A relatively small quantity of material is in the state of process at any one time, which is a real advantage in large plants or parallel systems.

5. The only high pressures in the plant are in tubular equipment thus making it possible to carry low pressure on all tanks and large vessels.

Combination Cracking Economics

EUGENE R. SMOLEY,
The Lummus Company

A SURVEY of the literature shows that the technical aspects of modern cracking developments have been more thoroughly treated than have the economic factors involved. Since a considerable interest is being shown in the installation of modern cracking units for the production of more and higher grade gasoline it is felt that further publication of economic studies will be of value to the industry.

It should be borne in mind that such studies are of general value when made as a basis of comparison, rather than as applying specifically to any one refinery or individual set of conditions. To anyone who has attempted to evaluate the economics of a proposed modern cracking unit it is apparent that there are a large number of variables to be considered. Among the more important of these are crude, gasoline and fuel oil prices, market requirements and specifications, the cost of materials of construction and the variation of installation cost with throughput and type of plant. Also there is the relation of operating costs to location and plant throughput. Plant location introduces variables such as labor market, water and power supply which affect the direct operating costs, and in addition influence the investment cost through type of construction, and transportation facilities.

The method of attack used in the preparation of this paper is applicable to the comparison of any refinery processes or types of equipment.

Dr. Smoley is sales engineer for The Lummus Company, New York. He was graduated as a chemical engineer from Massachusetts Institute of Technology and was awarded his doctor's degree from the same institute. For several years he was in charge of technical development in the Netherlands East Indies for Standard Oil Company (New Jersey). He is the author of many articles in chemical and technical journals and a member of leading chemical societies in the United States and England.

The accompanying paper was read before the technical session of the Twenty-sixth Annual Meeting of the Western Petroleum Refiners Association, at Hot Springs, Arkansas, April 25-27, 1938.

BASES FOR ECONOMIC STUDIES

For the studies made in this paper, cracking of 3.9 A. P. I. Mid-Continent crude for ultimate gasoline yields was selected. These studies were made for crude throughputs from 2,000 to 20,000 barrels (42 gallons) per operating day. Three types of units were considered. Flow sheets Figures 1 and 2 show two of these units, Two-Coil Crude Cracking and Two-Coil Topping and Cracking. The third is Separate Topping and Cracking. Prices of crude were selected in the range of $1.20 to $1.60 per barrel delivered to the refinery. Gasoline prices range from 4 to 7 cents per gallon at the refinery, and fuel oil prices from 60 cents to $1.20 per barrel. Gas produced was credited at an equivalent fuel value of 50 cents per barrel, or 10 cents per thousand cubic feet of gas. Percent return on investment was calculated on the capital expenditure for the unit itself within battery limits, neglecting tankage, utility and other auxiliary equipment. Normal royalty charges were included. A 90 percent service factor was used for all studies.

The direct operating costs as plotted in Figure 4 in dollars per barrel of crude throughput against barrels per day crude throughput were made from values obtained from 22 representative operations in this country and include direct operating labor, fuel, maintenance and cleaning, steam, water, power, air and chemicals. These direct operating costs represent the actual utilities used and at the prices paid at the refinery from which they were obtained. The percentage each one of these items represented in the total direct operating cost were averaged for the 22 sets of data at hand and are shown in Table 2. These fall in the following order of importance: fuel, labor, utilities other than fuel, and maintenance. In Table 2 is also shown the range of unit costs of these utilities.

Figure 1 shows the flow sheet of the Two-Coil Crude Cracking Unit. The crude, after receiving preheat from gasoline vapors, gas oil circulating quench stream and convection section of gas oil and viscosity breaker heater flashes in an intermediate section of the fractionator and separator tower. Visbreaker charge is removed from a pan below this

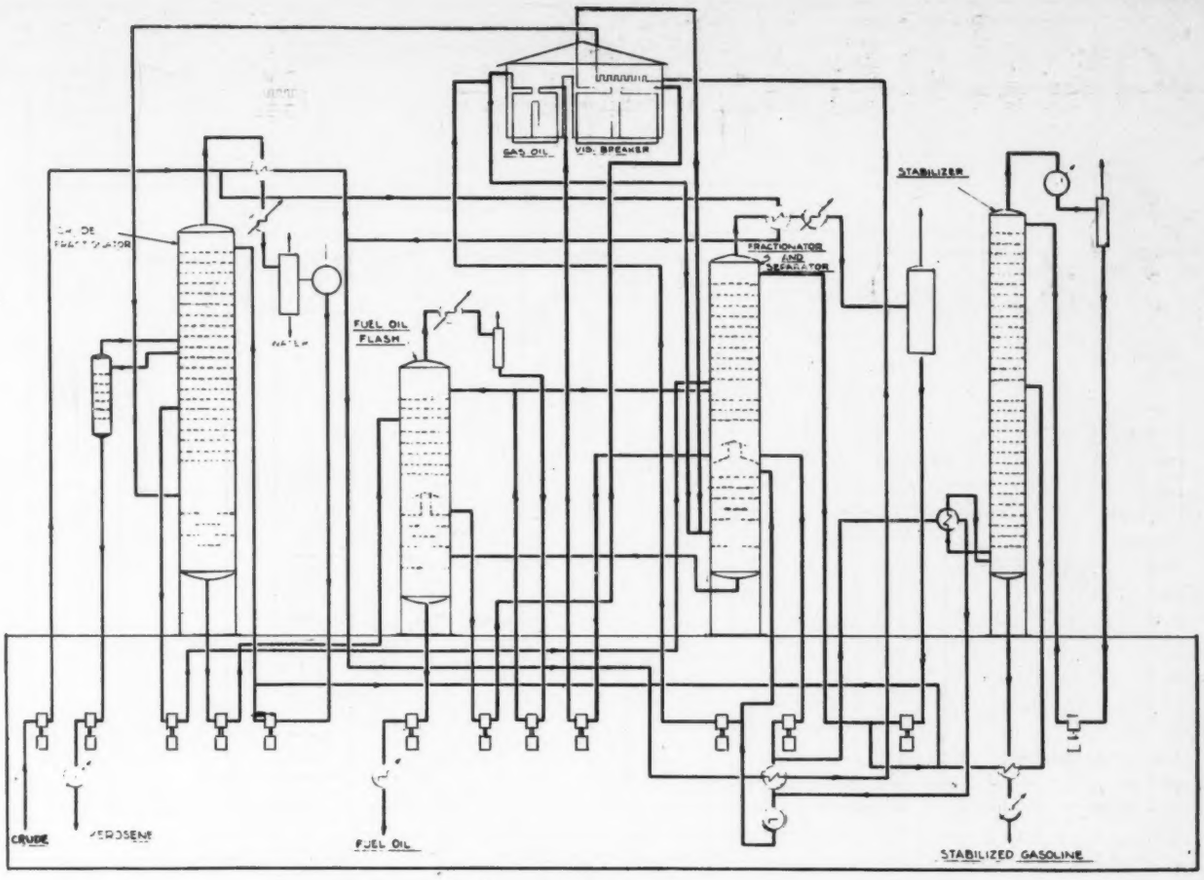


FIGURE 1

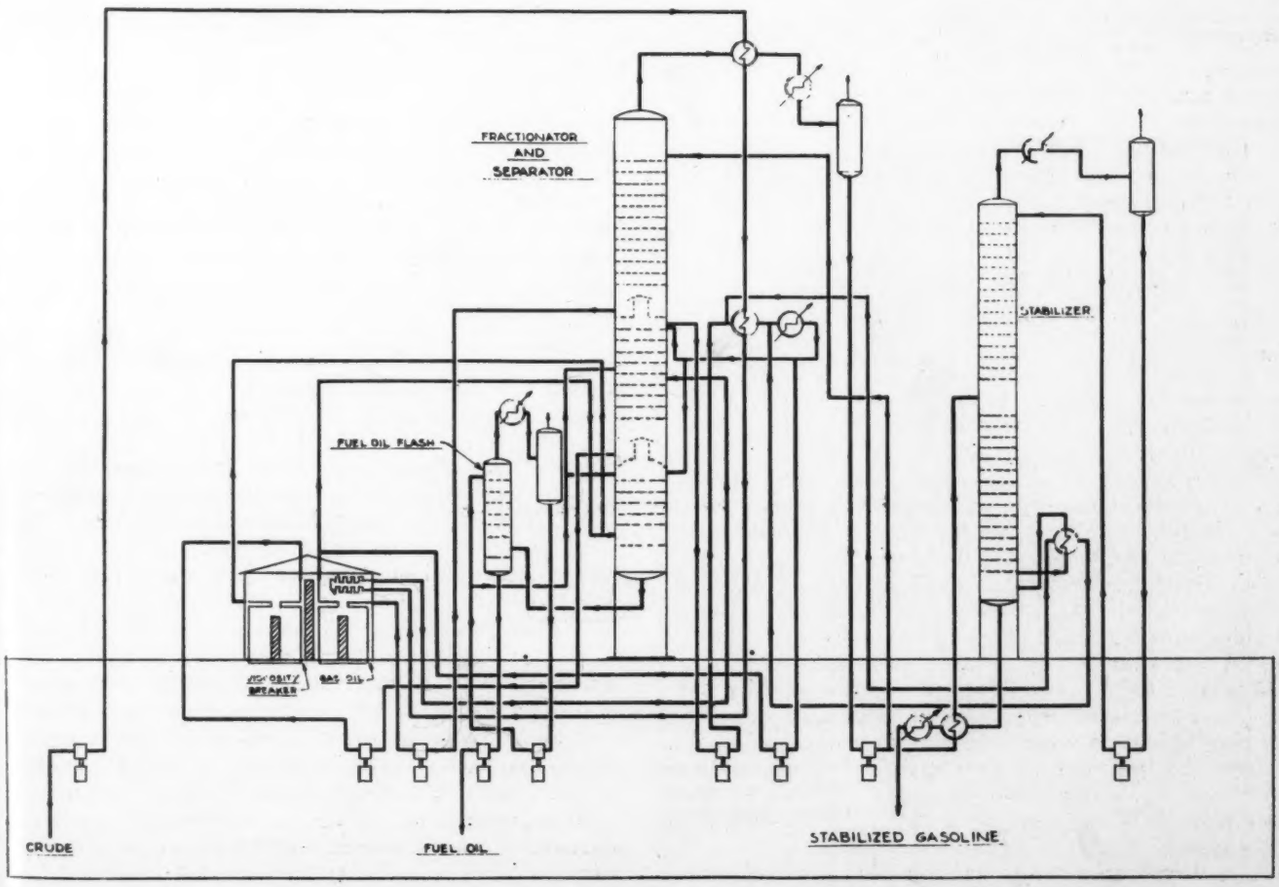


FIGURE 2

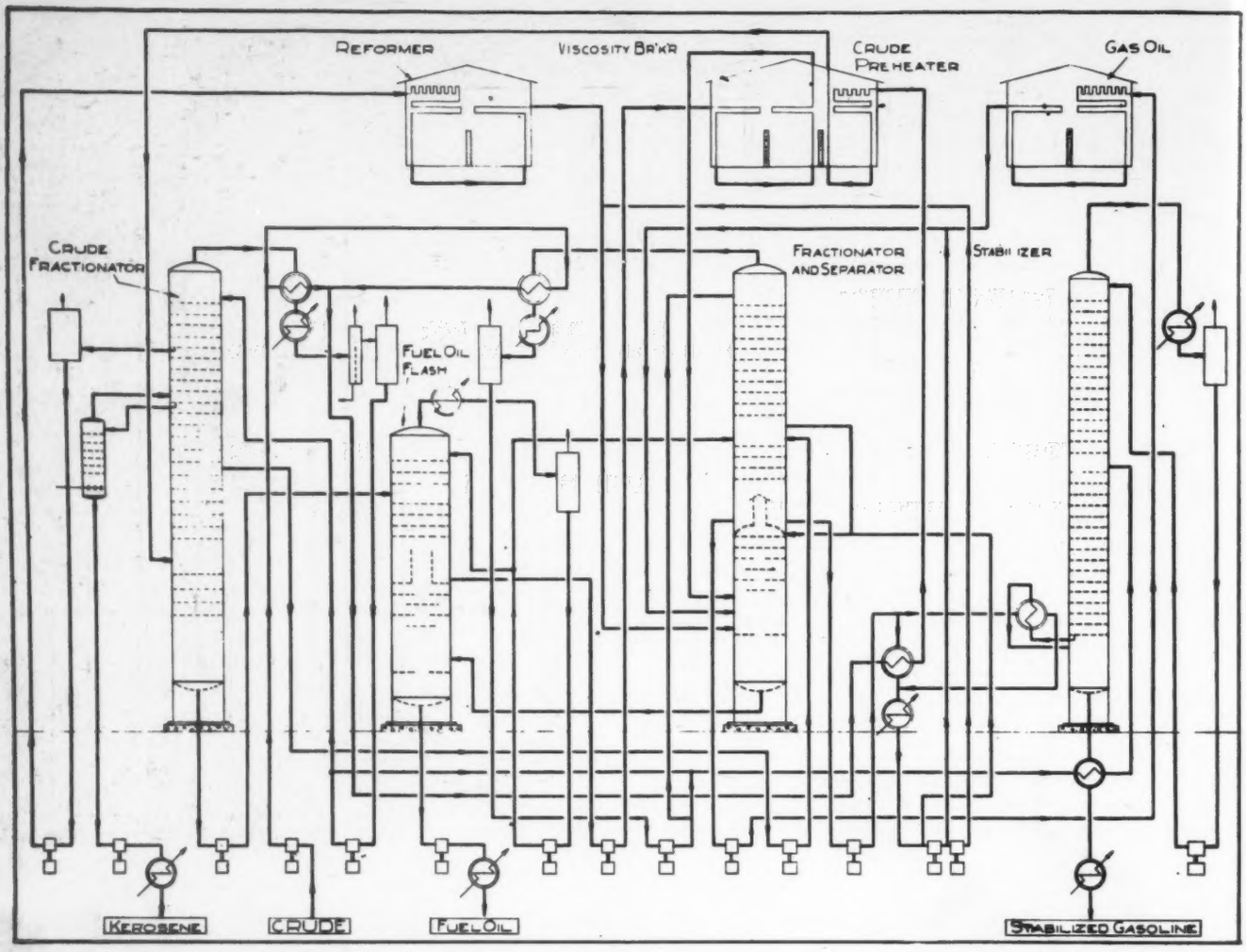
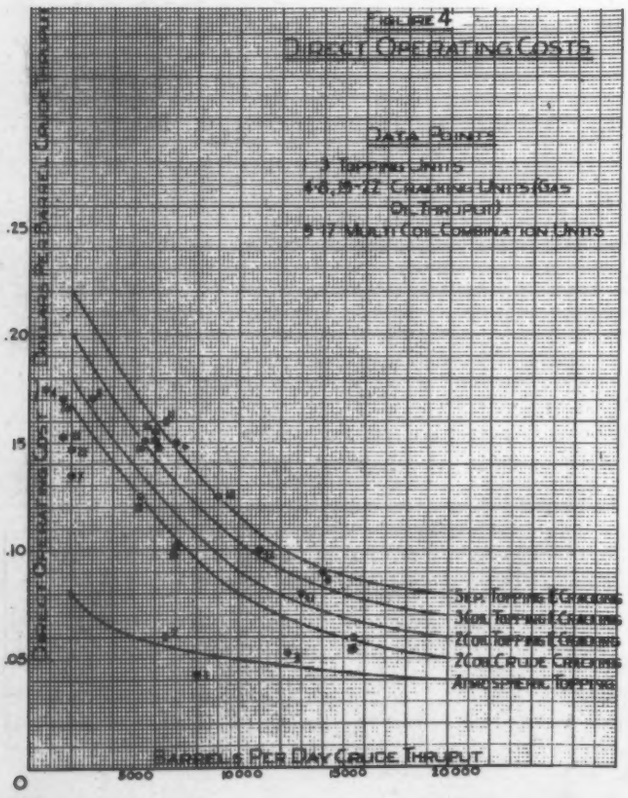


FIGURE 3



point and gas oil charge from a point above. Separator bottoms are flashed to fuel oil specifications and gasoline overhead is stabilized. Because crude is flashed in the fractionator, the end point of straight run gasoline must be the same as that of the cracked gasoline and no kerosene or other straight-run products can be removed.

Figure 2 is the Two-Coil Topping and Cracking Unit flow sheet. A separate crude fractionator tower permits variation in end point of straight-run gasoline, and the removal of kerosene or other straight-run products. In this unit the reduced crude from the topping tower picks up preheat and cycle stock in the fuel oil flash tower before going to the visbreaker furnace. The straight-run gasoline is stabilized along with the cracked gasoline. Furnace oil can be withdrawn through a stripper from the fractionator tower.

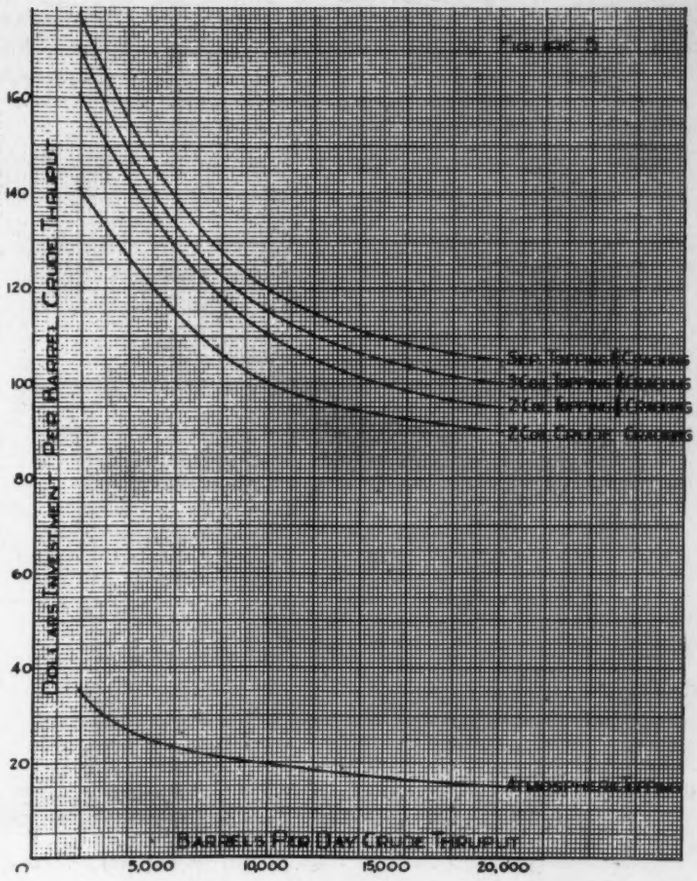
Figure 3 presents a flow sheet for the Three-Coil Topping and Cracking Unit. While this was not used in the present pay off studies because reforming of Mid-Continent naphtha is not necessary, the operating costs and investment costs of this unit are presented so that economic studies could be made on other crudes requiring reformer operation.

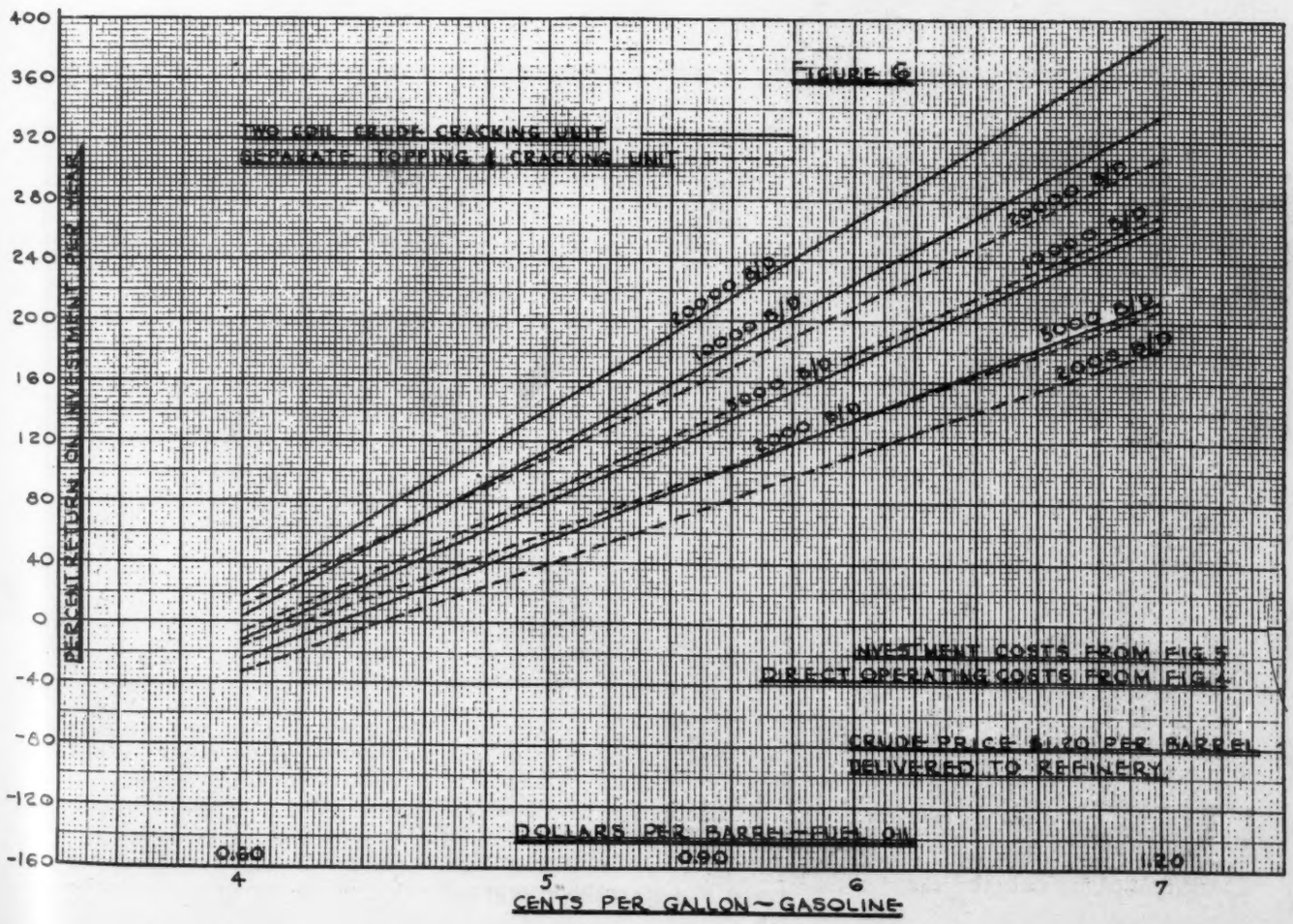
The analysis of the direct operating costs is complicated by such varying factors as operating technique, location, feed stock character, extent of side product removal, and the supply of steam, power and

water. The family of curves drawn are relative and to be used for comparison purposes. Adjustments were made to place the operating costs for the different operations on a comparable basis. There was little data to establish the low throughput end of the curves and it is here that different operations will vary more than at higher throughputs. The separate topping and cracking curve is lower than any calculations from data points 4 to 8 and 19 to 22 for cracking plus 1 to 3 for topping would show. In spite of the fact that this gives less advantage to combination topping and cracking, it was felt that it was a fairer basis in view of the many other variables. The curves drawn because they represent averages are more uniform than would actually be found from such comparisons of specific cases.

Figure 5 shows the investment costs in dollars per barrel of crude throughput for atmospheric topping units, for the types of combination unit shown in Figures 1, 2 and 3 and for separate cracking and topping units, all plotted against barrels per day of crude throughput. These comparative curves are based on one type of material specifications throughout. No alloy steels or lined towers were used and the design favors simplicity and operability.

The investment cost for the separate topping and cracking units, it will be noted, is even greater than that for three-coil combination topping and cracking units. While the studies were made on ultimate gasoline production, the flow sheets indicate that kerosene can be removed if desired and it is also possible to remove furnace oil by adding a stripper.





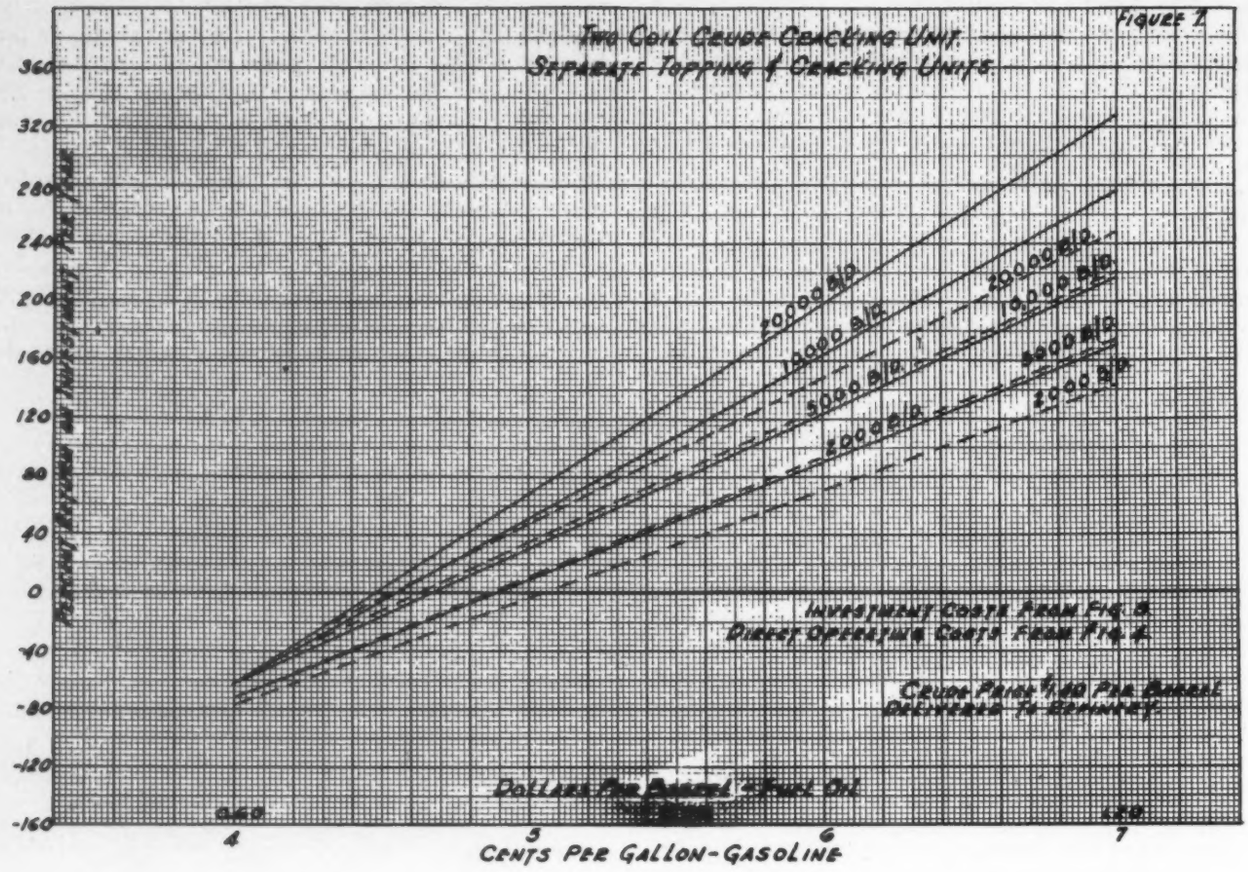


FIGURE 7.
TWO COIL CRUDE CRACKING UNIT.
SEPARATE TOPPING & CRACKING UNITS.
PERCENT RETURN ON INVESTMENT PER YEAR
360
320
280
240
200
160
120
80
40
0
-40
-80
-120
-160
$40000 B/D
30000 B/D
20000 B/D
10000 B/D
5000 B/D
2000 B/D
INVESTMENT COSTS FROM FIG. 3
DIRECT OPERATING COSTS FROM FIG. 4
CRUDE PRICE $1.60 PER BARREL
DELIVERED TO REFINERY
DOLLARS PER BARREL = FUEL OIL
4.60
4.80
5.00
5.20
4
5
6
7
CENTS PER GALLON - GASOLINE

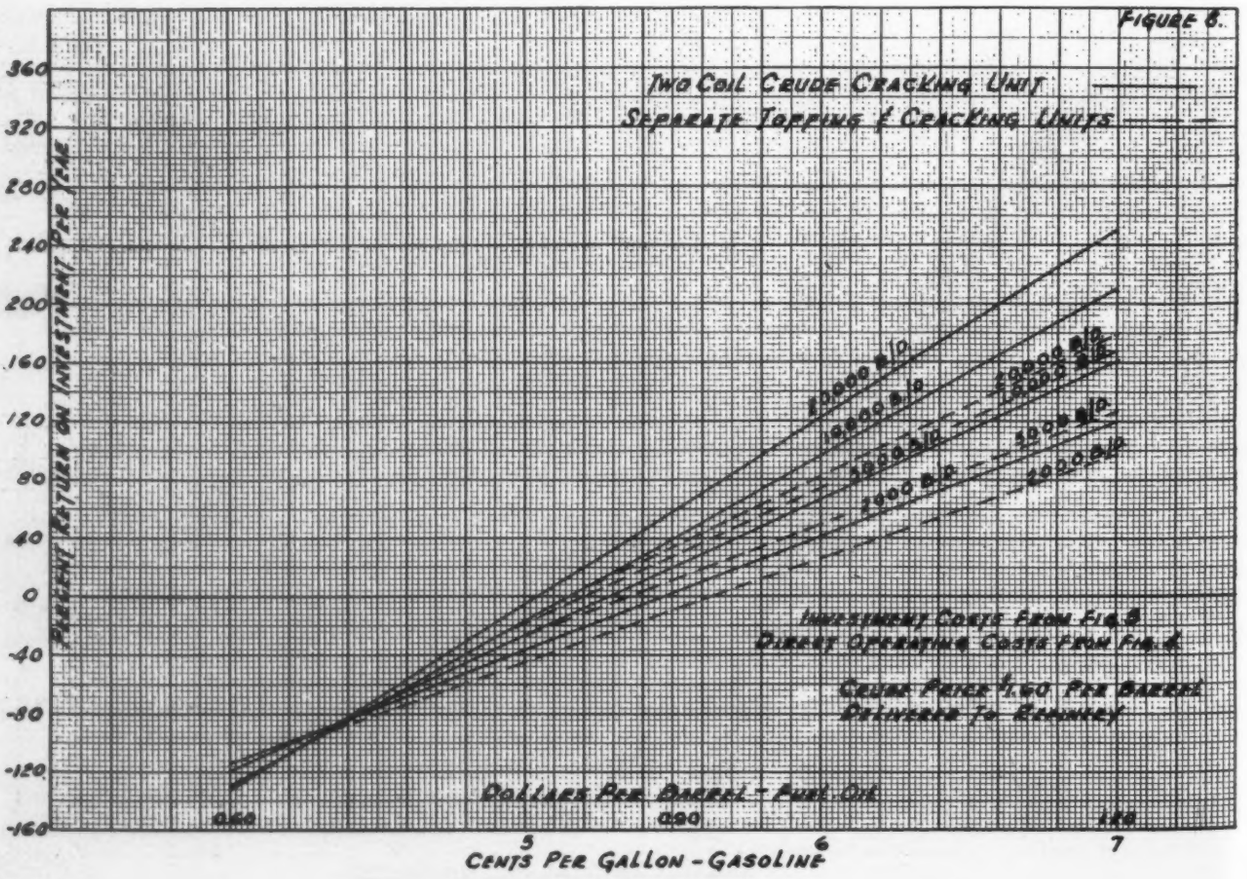


FIGURE 8.
TWO COIL CRUDE CRACKING UNIT
SEPARATE TOPPING & CRACKING UNITS
PERCENT RETURN ON INVESTMENT PER YEAR
360
320
280
240
200
160
120
80
40
0
-40
-80
-120
-160
$40000 B/D
30000 B/D
20000 B/D
10000 B/D
5000 B/D
2000 B/D
INVESTMENT COSTS FROM FIG. 3
DIRECT OPERATING COSTS FROM FIG. 4
CRUDE PRICE $1.60 PER BARREL
DELIVERED TO REFINERY
DOLLARS PER BARREL = FUEL OIL
4.60
4.80
5.00
5.20
4
5
6
7
CENTS PER GALLON - GASOLINE

TABLE 1
Yields (Volume Percent)

Mid-Continent Crude 36.9 API	Topping	Two Coil Crude Cracking (Figure 1) or Separate Topping and Cracking	Two Coil Topping and Cracking (Figure 2)	
Straight Run Gasoline	33	33	26	20
Cracked Gasoline	..	36	42	45
Total Gasoline	33	69	68	65
Octane Number, CFR	47	63	66	70
Fuel Oil	..	25	25	25
Gas Oil	16	..	..	..
Reduced Crude	50	..	..	..
Gas and Loss (weight percent)	1	6	7	10
Total	100	100	100	100

The yields of gasoline, fuel oil and gas used for these studies are given in Table 1.

DISCUSSION OF ECONOMIC STUDIES

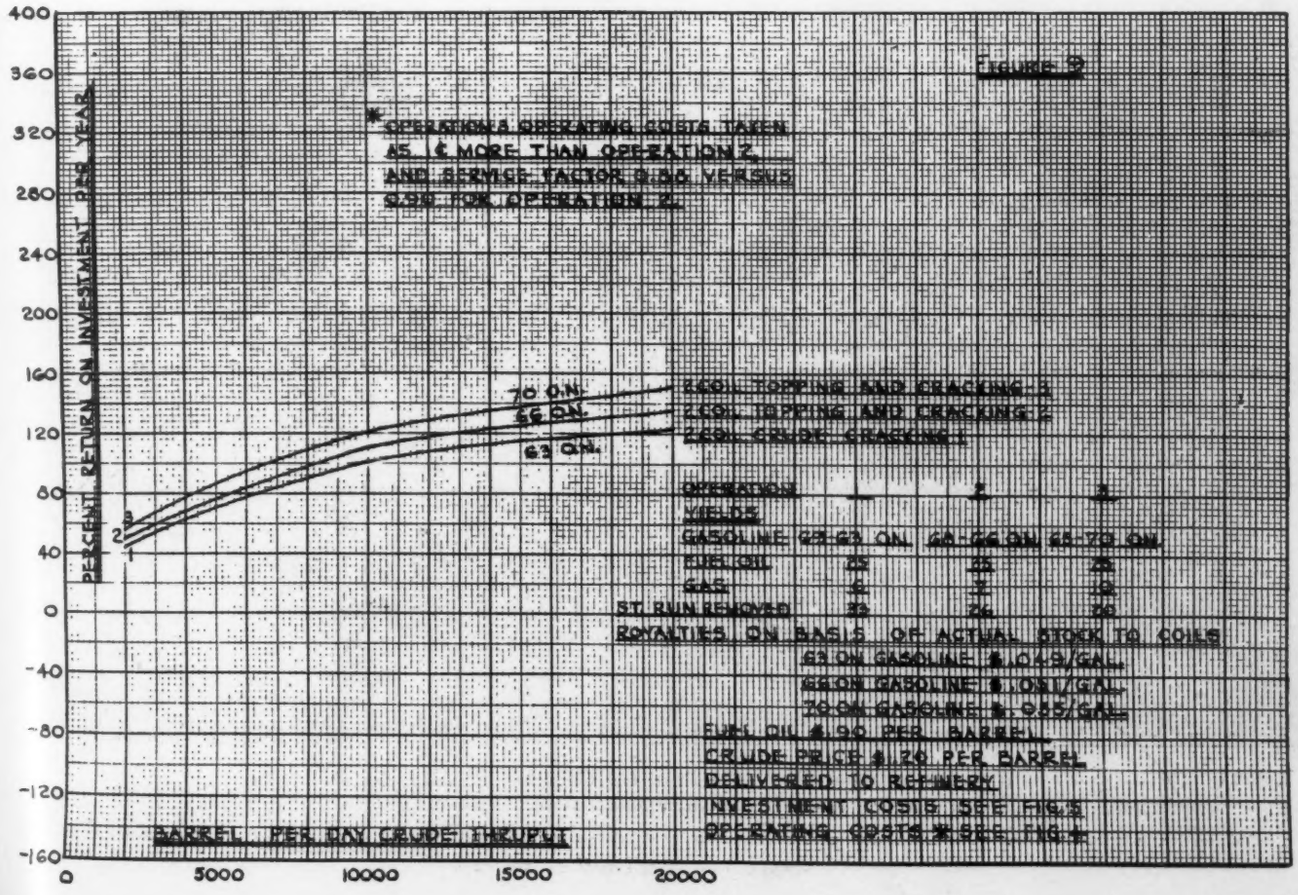
The values obtained from the calculations were plotted in Figures 6, 7, 8 and 9. The first three plots give families of curves showing the return on the investment for varying crude throughputs, crude, gasoline and fuel prices and type of plant. They show that the return on the investment increases with throughput and is greater for the two-coil cracking unit than for separate topping and cracking units. It is of interest that the factors affecting the return on the investment have the following order of importance: gasoline price, crude price, investment cost, fuel oil price, operating cost and royalty.

Figure 9 represents a study of the return possible with these different types of units at various crude throughputs, taking into consideration the octane number of the finished gasoline. It will be noted that the two-coil topping and cracking unit in spite of a higher investment cost has a more rapid pay off than the two-coil crude cracking unit. The return on the investment is still greater when the two-coil combination unit is operated for higher octane number.

In considering the possible return on the investment for a cracking unit other factors must be borne in mind. It is important that the capital invested in the equipment should become productive as rapidly as possible. The minimum time should be taken, therefore, for construction and initial operations. It is possible today to have a unit delivered in seven months and to produce specification products at full capacity on the initial run. The design and general arrangement of the unit also affects

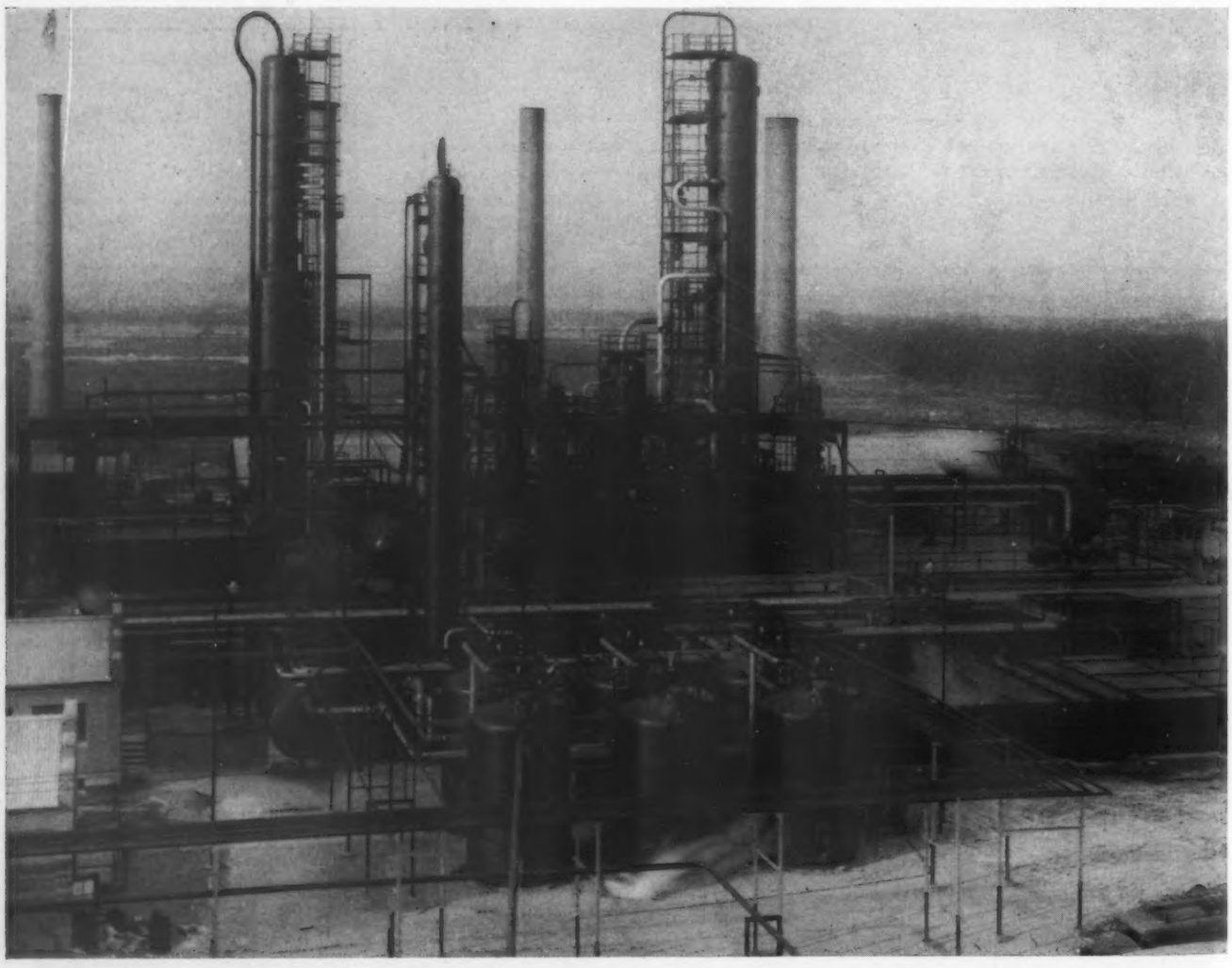
TABLE 2
Average Breakdown of Direct Operating Costs

	Percent	Range Unit Cost
Labor	22	$0.40 to $1.00 per barrel
Fuel	36	
Maintenance and Cleaning	20	
Steam	22	20-35¢ per 1000 lb
Power		0.4 to 1.25¢ per KW
Water		0.3 to p.5¢ per 1000 gallons
Air, Chemicals		
	100	



the possible return through easy operability, freedom from mechanical difficulties and maintenance of high service factor. Rapidity of turnaround is of advantage not only from the standpoint of lost stream time, but also in decreasing mechanical maintenance charges. Since the equipment will be bought with an expected life of about 10 years, it is necessary for the design to incorporate sufficient flexibility to permit changing crudes or adjusting products to a wide range of possible future requirements.

From the average relationships derived in this paper it appears that the refiner who is contemplating the installation of new cracking equipment will profit by a thorough study of all the specific variables which apply to his refinery and which enter into the establishment of optimum return. Refiners willing to increase somewhat their investment for new cracking equipment will be interested in the economics of combination processes for increasing yields of overall gasoline production with accompanying octane increase to the range of 74 to 80.



New Combination Unit, The Pure Oil Company, Toledo, Ohio

Chlorination of Cooling Waters

PREVENTION or curtailment of heat-transfer losses through the elimination or control of slime formation in heat-exchange units has been successfully accomplished in a wide variety of industrial plants and processes, with the practice of cooling-water chlorination.

The process of de-sliming by chlorination for the purpose of improved heat transfer is based on recognition of the fact that most deposits on the tube surfaces of low-temperature heat exchangers are organic in origin, attached and accumulated by the action of algae and bacteria. It is the purpose of this article to outline the effect of bacteria and algae in slime fouling, to discuss the application of chlorine for slime control, and to enumerate certain fundamental factors which may not be overlooked in the interests of complete and positive slime prevention.

N. C. ESTES
District Engineer,
Wallace & Tiernan Products, Inc.

SINCE the turn of the century, chlorination has been standard practice for the destruction of pathogenic micro-organisms in domestic and public drinking water supplies. Acceptance was due to its greater disinfecting efficiency over other known germicides and with the development of highly-efficient apparatus for the accurate control of the commercially-available liquid chlorine. Its use was quickly extended to include application in sewage treatment, swimming-pool sterilization, and during the late twenties for the control of slime on the tube surfaces of condensers and other low-temperature heat exchangers. In the latter field, investigations were originally confined to the larger steam generating stations but during recent years a greater appreciation of the fact that heat-transfer losses might be due to slime fouling has led to the application of chlorine in industrial plants wherever cooling-water systems are integral to plant processing.

BIOLOGICAL STUDIES

Bacteria are unicellular plants, all microscopic in size, having three marked characteristics accounting for their classification as plants. They are composed of undifferentiated protoplasm without a nucleus; they occasionally possess a cellulose membrane like the higher plants; and they have the biological tendency to break down as well as synthesize organic compounds. Algae are higher plants, visible to the eye, variously colored, but usually green, due to the presence of chlorophyll, which is the catalyst enabling them to synthesize carbon dioxide and water into glucose by means of energy furnished by sunlight.

Bacteria are always present in the air and require water for the life process. They will be found in all cooling-water systems by reason of contact with the air either in open cooling towers, force-draft towers (where the amount of air-borne bacterial contamination is considerable), open-type box heat-exchangers, as well as in the make-up water when it is of surface origin, and often in well supplies, where organisms of the iron bacteria group predominate. Green algae forms will usually be found with the lower bacterial groups, particularly when sunlight is present. Leucoplasts (white algae) and sometimes, especially in a brackish cooling water, chromoplasts (plants of any other color) will be found. All these organisms contribute to slime fouling and their action is one of mechanical entanglement of mud, silt, scale, and suspended organic matter. This binding action will be accentuated by the life processes of the organisms as they synthesize their food supply and multiply. Multiplication is a decided factor in the accumulation of deposits as evidenced by the fact that a single bacterium dividing at the nominal rate of once every hour would produce 17,000,000 bacteria in 24 hours. Speed of deposition is, therefore, an outstanding characteristic of slime deposits.

Organic slimes and scales are often difficult to recognize as such since they are sometimes compounded with and simulate mineral scales. Deposits due to slime fouling vary in organic content from 15 to 35 percent and a laboratory analysis establishes the problem as one of slime, mineral scale, or a combination of both.

Investigators have noted that in refinery practice oil leakage into the cooling water is also bound on tubes by micro-organisms to further complicate the slime fouling. There is evidence that a white thread-like or sphaerotilus-type organism is dependent upon the presence of oil and that a tough spongy deposit characterizes this type of fouling.

It is granted that this bacterial concept of deposit formation is not immediately acceptable unless the investigator is accustomed to thinking in biological

terms. For that reason it is important to differentiate between the visible green chlorophyll-bearing algal forms, usually evident on open cooling towers, and those miscroscopic bacterial forms which do not require sunlight in the life process and are evident only under the microscope. These latter, however, would be present due to air-borne contamination and would be carried to the heat exchangers to proceed with their binding action to interfere with heat transfer.

FIGURE 1
Small Capsulated Bacteria—Mag. 900 X.

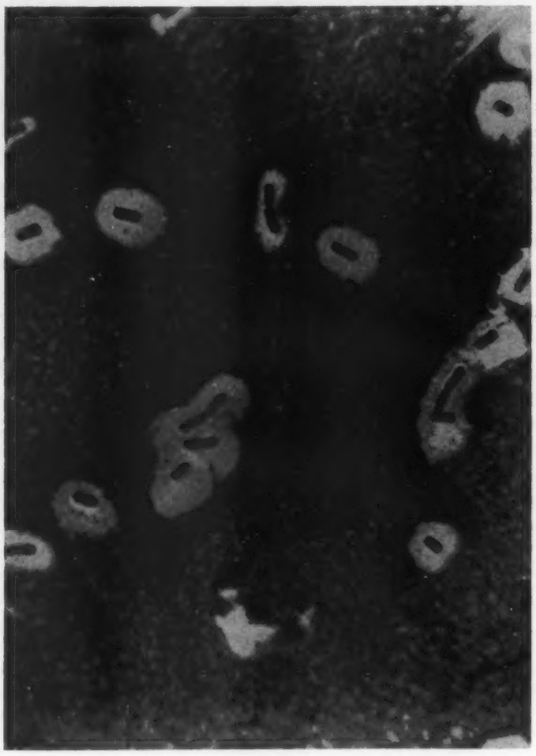


FIGURE 2
Large Capsulated Bacteria—Mag. 900 X.

Since the many types of bacteria vary in their physical character, origin, food and environmental requirements, and protect themselves in a greater or lesser degree against unfavorable conditions, it is present day routine to collect samples of slime for laboratory analysis.

Figures 1 and 2 show types of capsulated bacteria frequently found in slime samples, as reproduced by photomicrographs. These capsulated bacteria form sticky, gelatinous slime accumulations on tube surfaces and account for rapid-growing deposits, particularly whenever turbidity or other suspended matter is present in the cooling water.

Figure 3 illustrates organisms of the stringy filamentous variety of the iron bacteria group. It is perhaps worth noting that although this slime former will gather ferrous iron in its life process and oxidize it to the ferric state in the form of a tubercle on a pipe or other iron surface, the presence of iron is not essential to its existence.

In the laboratory, the organisms found in the slime sample are classified by group. If the predominant types are not recognized, pure strains are isolated and identification tests are continued. The classified types are then examined for their resistance to varying chlorine dosages and varying periods of contact with the chlorine. The minimal-chlorine death-rates are determined in these studies and the percentage kill is evaluated by comparison with an unchlorinated control.

Tables I and II show typical time-of-killing reports.

TABLE 1

Minimal Chlorine Death Rates Small Capsulated Bacteria

Treatment Time	CHLORINE RESIDUAL					
	0.5 p.p.m.		1.0 p.p.m.		2.0 p.p.m.	
	Final Plate Count x 1000	Percent Mortality	Final Plate Count x 1000	Percent Mortality	Final Plate Count x 1000	Percent Mortality
5 Min....	68.0	23.7	40.0	55.0	36.0	59.5
10 Min....	58.0	35.0	47.0	47.2	29.0	67.4
20 Min....	68.0	23.7	45.0	49.5	25.0	72.0
60 Min....	32.0	64.0	37.0	58.5	3.3	96.3

Notes:—Final plate counts record number of bacteria, per cu. cm. of suspension, remaining at close of treatment period.
Chlorine residual values are maintained for duration of treatment.
Averaged plate counts of initial untreated suspension determined as 89,000 bacteria, per cu. cm.

CHLORINE REQUIREMENTS

Determination of the organic content of the tube deposits, identification of the offending organisms, and chlorine-kill determinations are the preliminary steps in determining the desirable approach to a solution of the problem, but further data is required. When chlorine is applied to water, some of it reacts completely with organic matter present, with certain dissolved gases, perhaps with some inorganic salts, and in refinery practice with oils and gases which occasionally leak into the cooling water. The quantity of chlorine required to satisfy these reactions is known as the chlorine demand of the water and it is not a constant factor. Excess or

residual chlorine available after the satisfaction of this demand, expressed in parts per million, is the criterion of sterilization and we must, therefore, state the chlorine demand of any water in relation to time of contact and the residual maintained. Chlorine-demand determinations must be made at the time the sample of cooling water is collected, and supplemented by the laboratory data. It is then possible

FIGURE 3
Iron Bacteria—Mag. 400 X.

to estimate the individual chlorine requirements of any given cooling water to effect slime control.

Figure 4 shows a chlorine-demand study of a highly-contaminated water and is of particular interest as illustrating the fact that the relationship of dosage to residual is not a straight line.

MECHANICAL EQUIPMENT

During the period when this de-sliming process was in its development in the steam-generating field, many mechanical problems came to light, especially those involving equipment capacity, flexibility, and the economical application of chlorine to high circulating-water rates. The design of the high-feed vacuum chlorinator, the motor-operated chlorine valve and accessory equipment, resulted in application of the principles of chlorination-by-rotation to further develop the intermittent process of circulating-water chlorination as conceived and patented by Dr. J. C. Baker. These points are mentioned briefly and in passing, since the benefits and principles of the preliminary work may now be applied to the industrial field.

However, it does bring up the question of intermittent versus continuous chlorination which, as may be seen, is often influenced by the physical characteristics of the particular cooling-water system under consideration.

The original application of chlorine to a cooling-water system for slime prevention in a surface condenser is reported to have been performed in England. Other early installations here and abroad were of the spray-pond or cooling-tower type and chlorine was applied continuously to the circulating-pump suctions. This was economical from the practical point of view where the cooling water was continually recirculated, but it became immediately apparent that continuous chlorination of high-circulating rates of cooling water discharged to waste at larger steam-generating stations required expenditures for chemicals in excess of the savings in fuel and labor of cleaning. The work of Dr. Baker established the principle of intermittent chlorination, whereby it was demonstrated that it was possible to use unchlori-

TABLE 2

Minimal Chlorine Death Rates Large Capsulated Bacteria

Treatment Time	CHLORINE RESIDUAL			
	0.1 p.p.m.		0.35 p.p.m.	
	Final Plate Count x 1000	Percent Mortality	Final Plate Count x 1000	Percent Mortality
10 Seconds	10.5	93.0	10.0	93.3
30 Seconds	11.0	92.7	9.8	93.3
45 Seconds	11.0	92.7	5.4	96.4
1 Minute	10.0	93.3	4.7	96.8
3 Minutes	9.0	94.0	3.8	97.5
5 Minutes	2.3	98.5	3.4	97.7
10 Minutes	5.2	96.5	1.5	99.0
15 Minutes	4.8	96.8	1.0	99.3

Notes:—Final plate counts record number of bacteria, per cu. cm. of suspension, remaining at close of treatment period.
Chlorine residual values are maintained for duration of treatment.
Averaged plate counts of initial untreated suspension determined as 150,000 bacteria per cu. cm.

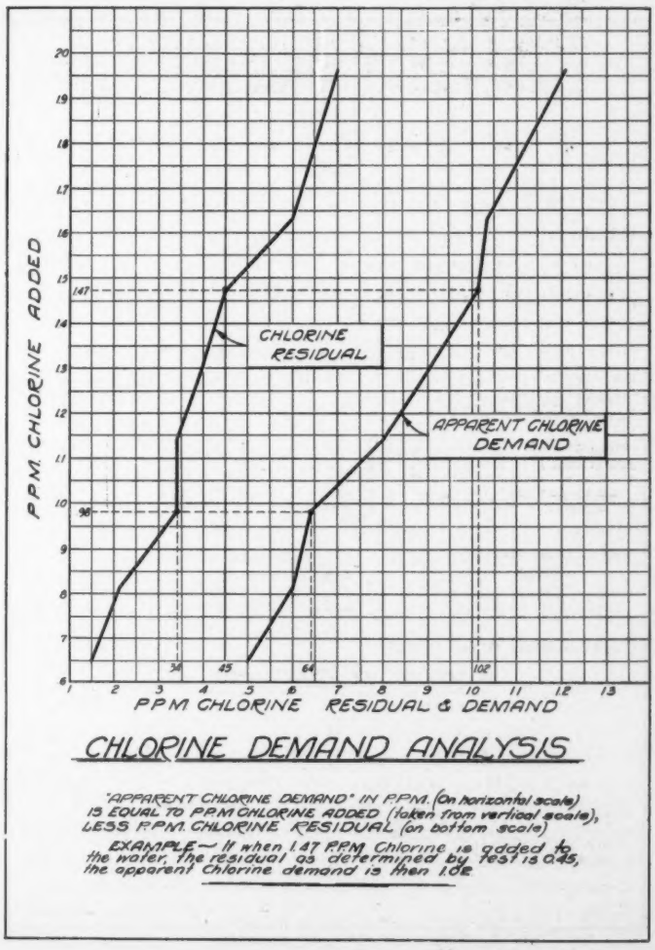

P.P.M. CHLORINE ADDED
CHLORINE RESIDUAL
APPARENT CHLORINE DEMAND
P.P.M. CHLORINE RESIDUAL & DEMAND
CHLORINE DEMAND ANALYSIS
"APPARENT CHLORINE DEMAND" IN P.P.M. (On horizontal scale) IS EQUAL TO P.P.M. CHLORINE ADDED (taken from vertical scale), LESS P.P.M. CHLORINE RESIDUAL (on bottom scale)
EXAMPLE— If when 1.47 P.P.M. Chlorine is added to the water, the residual as determined by test is 0.45, the apparent Chlorine demand is then 1.02

FIGURE 4

nated water for an extended interval with a consequent accumulation of a slight slime film, provided it was immediately followed by a period of chlorination which would remove the newly-formed film. The same reasoning applies to the industrial cooling-water field. Those plants utilizing a raw surface water for cooling, pumped from the source through the heat exchangers and then to waste, would find intermittent desliming the most practical method of chlorine application. Conversely, the industries operating a recirculated supply, cooled by means of towers or spray ponds would find continuous chlorination to their advantage.

Selection of the mechanical chlorine-control equipment is based on the above data supplemented by a careful hydraulic survey of the individual plant and cooling-water system. Experience dictates that although the daily chlorine requirements may be established at a certain amount, it is good practice to have available reserve capacity greater than the estimated consumption. At first glance this appears incompatible with the requirement of detailed preliminary studies adopted to establish the chlorine requirements. This reserve capacity is needed however, to initially clean up the fouled system. After control is effected the problem becomes a preventive one and the chlorine dosage drops to the original estimates. Furthermore, reserve capacities become invaluable during seasonal increases in chlorine demands of surface cooling waters. Occasionally it is found that the organisms will also change seasonally and flexibility in capacity ranges makes possible the rescheduling of treatment methods. If equipment is properly selected, this reserve capacity may well be provided on the initial installation at little or no added expense, and it does not adversely affect normal operating costs.

In refinery practice the provision of the reserve capacity is even more important since oil and gas leaks may develop during a refining run. Under such conditions, the leakage may not be sufficient to warrant shutting down the unit for repairs but an increase in chlorine demand, due to the oil or gas leakage, must be temporarily taken care of. Gas appears to be a greater factor influencing the chlorine demand than does oil, but either will justify the reserve capacity. A short period of higher chlorination rate at the end of a refining run has proven preferable to the sacrifice of slime control during such an interval. Various investigators have reported that less chlorine will be consumed by maintaining control at higher dosages for a short period than would be required to re-clean the system after it has been permitted to foul. This becomes apparent when it is reconsidered that slime control is essentially a problem in sterilization.

Prevention of the growths at the lowest consumption of chlorine is the objective of the process rather than periodic cleaning, with heavy chlorine dosages, of systems which may have become fouled for one reason or another.

Figure 5 illustrates one type of chlorinator arrangement designed for operation on the intermittent basis. The feed range available on this type of

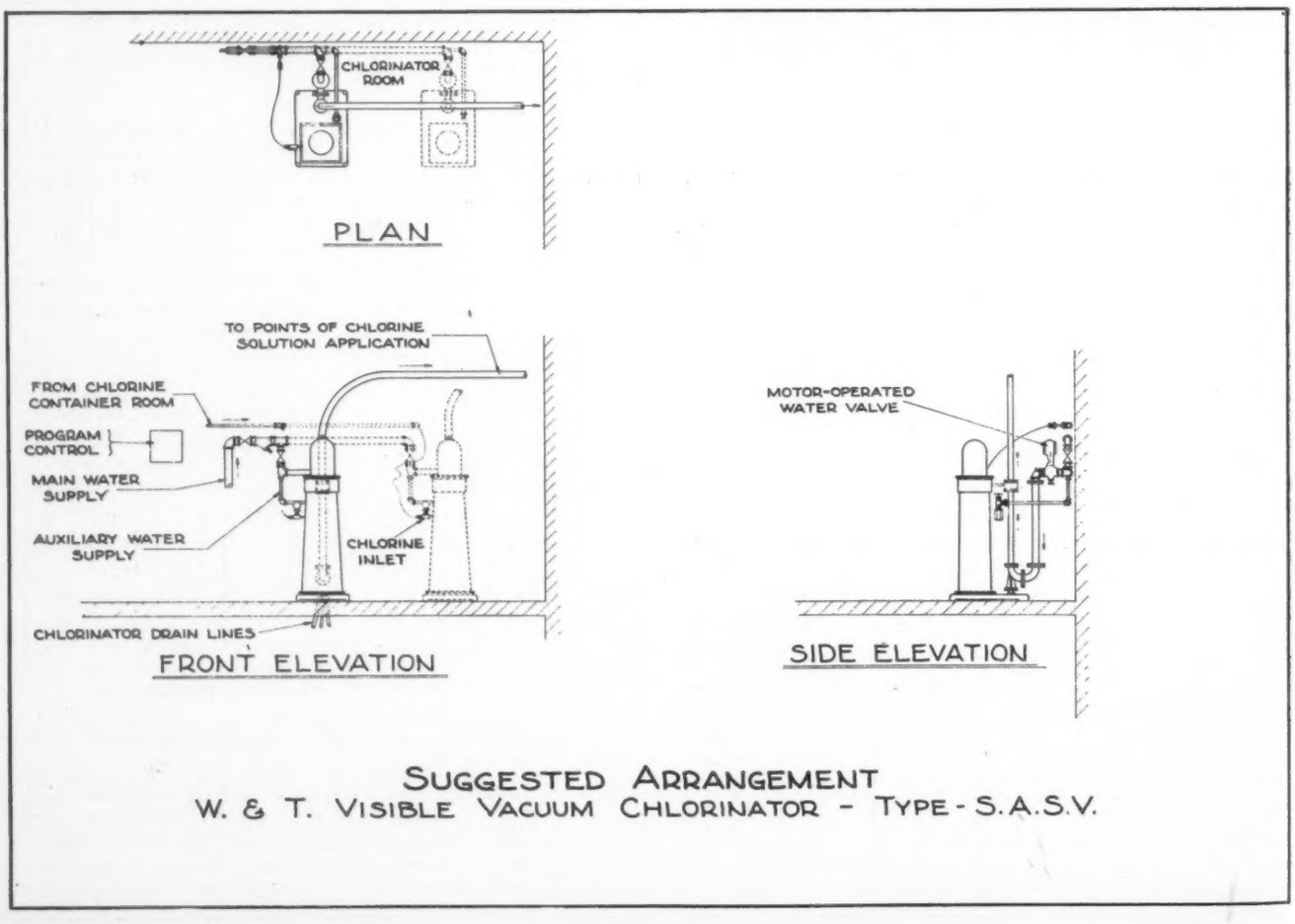


FIGURE 5

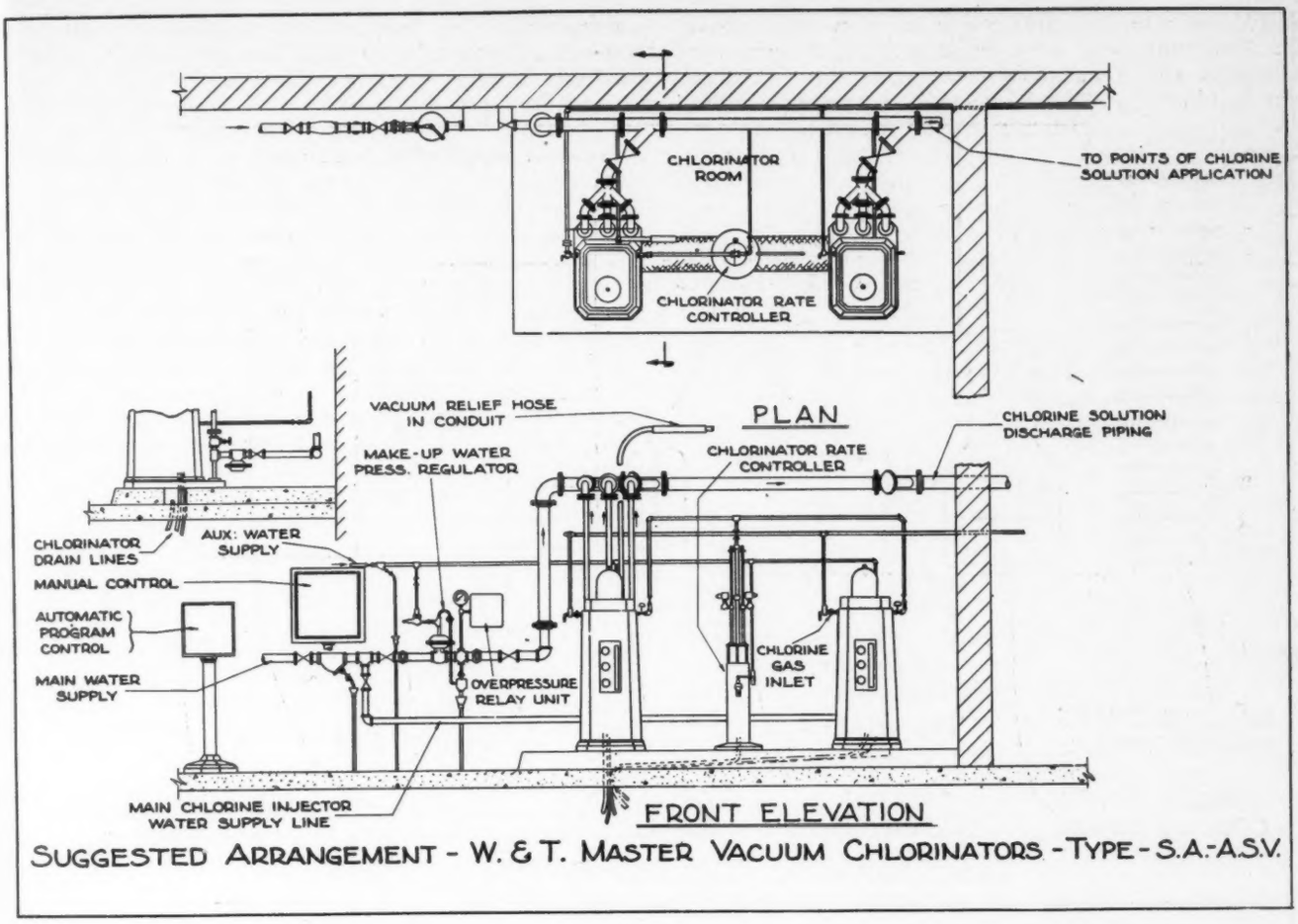


FIGURE 6

solution-feed vacuum chlorinator is from 2 to 720 pounds of chlorine per 24 hours.

Figure 6 shows the high-capacity type of solution-feed vacuum chlorinator operating in ranges from 200 to 2000 pounds of chlorine per 24 hours.

Figure 7 illustrates continuous chlorination for a recirculated cooling-water system, including prechlorination at the make-up water treatment plant. It has been established that most efficient control is effected when chlorine is applied as near as possible to the point of introduction of the contamination to the system. It follows that residual chlorine must be carried in the cooling water to the most remote point in the system where slime control is to be effected. In fact, if a slight residual can be returned to the cooling tower basin maximum efficiency is the result.

PLANT INSTALLATIONS

Rather than to describe in specific detail actual slime-control installations in the respective fields of power generation, natural gas compression, natural gasoline recovery, crude oil refining, and an industrial plant representative of general process, it is believed that a better picture can be presented by averaging the operating data into four hypothetical installations as represented by a compressor station, a natural gasoline plant, an oil refinery, and an industrial plant.

COMPRESSOR STATION

Slime fouling caused operating difficulties in the nature of varying engine-head temperatures with attendant cracking, high replacement costs, and increased outage of compressor units for manual cleaning, with accompanying labor costs at relatively high man-hourage. Slime studies showed presence of the iron bacteria group killed at residuals of 0.5 p.p.m. chlorine. Samples of engine-head scale showed little effervescence to hydrochloric acid, and 20 percent organic content. Equipment selected at capacity several times the estimated consumption and full feed was utilized for the initial clean-up. Continuous chlorination at the end of 60 days showed a slime-free system, all engine temperatures maintained at uniform level, elimination of engine-head cracking, lessened outage, reduced labor of cleaning, and a reduction in lubrication costs due to lower engine temperatures. Although some of the items were difficult to evaluate mathematically, a daily chlorine cost of 50 cents and a capital investment of $1200 was justified to the operating staff and to the management.

NATURAL GASOLINE REFINERY

A cooling tower system had an average 12-degree approach to wet-bulb temperature, and high year-round relative humidities. Heat exchangers were originally over-designed for cooling surface, but an increased production schedule required maximum heat transfer at close to the limit of original design. The absorption tower produced a terminal temperature difference of 12 degrees due to slime at the end of one week after manual cleaning. Immediately after manual cleaning the terminal temperature difference was 3 degrees. Gas was sold under definite guarantee

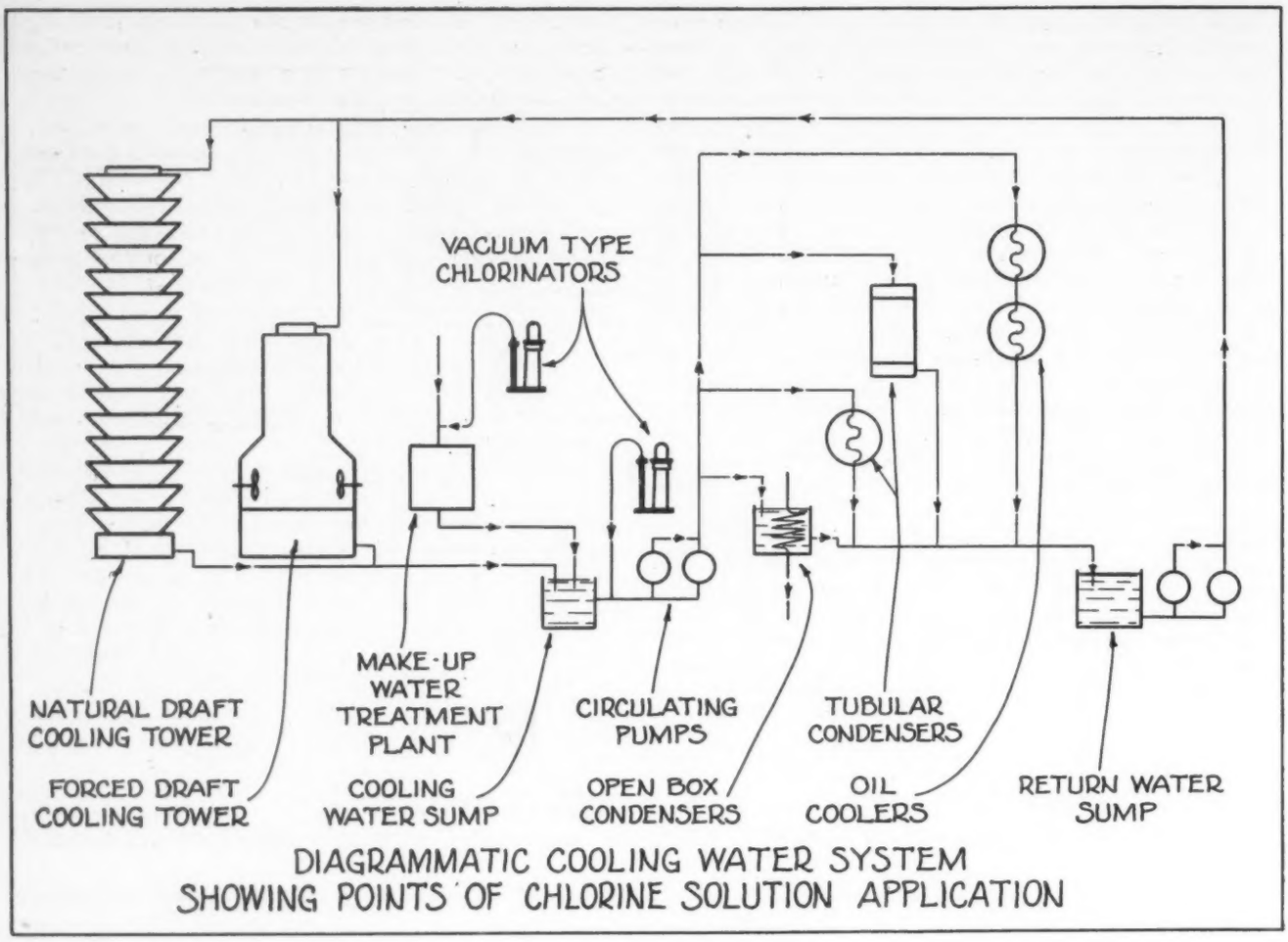


FIGURE 7

as to residual gasoline content and could not be met at temperature differences over 6 degrees. The owners were faced with the necessity of constructing an additional plant in order to meet the guarantee. Chlorination brought terminal temperature differences from 12 degrees to 2 degrees after two weeks and maintained thereafter at that point with elimination of manual cleanings and a delivery of gas to purchaser well within guarantee. Daily chlorine cost in winter months was 20 cents and during the summer approximately 40 cents. The capital investment of $1200 was written off in three months, evaluating all economies as conservatively as possible.

OIL REFINERY

The plant comprised two identical refining units and for the purposes of comparison, it was decided to chlorinate one, using the other as a control. On a 40,000-gallon circulating rate, slime control was effected in two weeks. Oil leakage had resulted in the accumulation of a particularly tough yellowish slime in box condensers as thick as one fourth of an inch. Chlorine killed the binding organisms and had the effect of breaking down the colloids of the bound oil, to leave a clean tube surface. Heat transfer studies on shell-and-tube-type heat exchangers were discontinued on account of difficulty of using empirical formulae in correcting for condensation of a mixture of volatiles. After the system had been cleaned a gas leak developed on a horizontal box condenser with an attendant increase in the chlorine demand. Full chlorinator capacity was utilized to maintain control but eventually the increasing leakage exceeded the chlorine capacity and chlorination was discontinued when the chlorine residual failed. After the leak was repaired, on a subsequent refining run, control was effected at the original estimated chlorine consumption. The chlorinated refining unit was slime-free and the unchlorinated unit used as a control was badly fouled. During one month on the latter system, the screens at the tower basin were cleaned approximately 200 times at an average of two man-hours per cleaning whereas the chlorinated system received two screen cleanings. Labor savings could be evaluated as sufficient to justify the cost of chlorine and fixed charges on the $2500 investment, entirely aside from economies in heat transfer in the exchangers.

INDUSTRIAL PLANT

Sea water used for cooling purposes at a 25,000,000-gallons-per-day rate discharged to waste after passing through the plant. Whereas the previously cited installations were continuously chlorinated since they were re-circulated systems, plant and biological surveys in this instance required intermittent chlorination for maximum chlorine economy. Chromoplasts of various types, varying seasonally, required a considerable amount of laboratory study, and bacterial-kill studies were invaluable for deter-

mining the periods of interval and chlorination cycles. Enlargement of plant subsequently required the installation of a high capacity chlorinator and the original machine was transferred for synchronized rechlorination of one portion of the cooling water going to external heat exchangers where the particular growths required a greater residual than was needed in the remainder of the system.

An interesting problem of mussel control was encountered. Although they are controllable in the spat stage of growth, the adult mussel closes up in the presence of chlorine, refusing food, and thereby resists a nominal dosage of chlorine. However, when chlorination is applied continuously for sufficient time, lack of food forces the mussel to open, therefore becoming vulnerable to chlorine. The dead mussels are then flushed from the system. This schedule of continuous chlorination therefore replaces the intermittent method once or twice a year when mussels are one of the cooling-water problems.

A portion of the cooling water goes to a surface condenser where the economics of chlorination are easily calculated. This is measured in terms of average vacuum loss between periods of manual cleaning by manual methods. Chlorination maintains the tubes slime-free with a corresponding improvement in vacuum which can be translated back into fuel savings at the grate. This makes an easy measurement of the economics of chlorination, but it is, of course, limited to the steam-electric generating field.

The foregoing hypothetical installations, based on field experience and data, afford an opportunity for consideration of de-sliming as applied to an average cooling system. Since every system is, however, a separate problem and general rules will not specifically apply to a particular slime-fouling condition, this article might profitably conclude with a suggested outline for a sound approach to a given problem in the interests of a complete and positive control.

SUMMARY

1. The first procedure is the collection of samples for laboratory determinations of the type of organisms and chlorine time-of-kill studies. Obviously, this presupposes the availability of a biological laboratory equipped for this type of work, and for proper interpretation of results.

2. Scale samples should be examined to determine whether the deposit is organic in origin, or a true mineral scale, or a combination of both. This differentiation is most important, supplemented by a survey of temperature rises through the heat exchangers with proper weight given to the temperature factor.

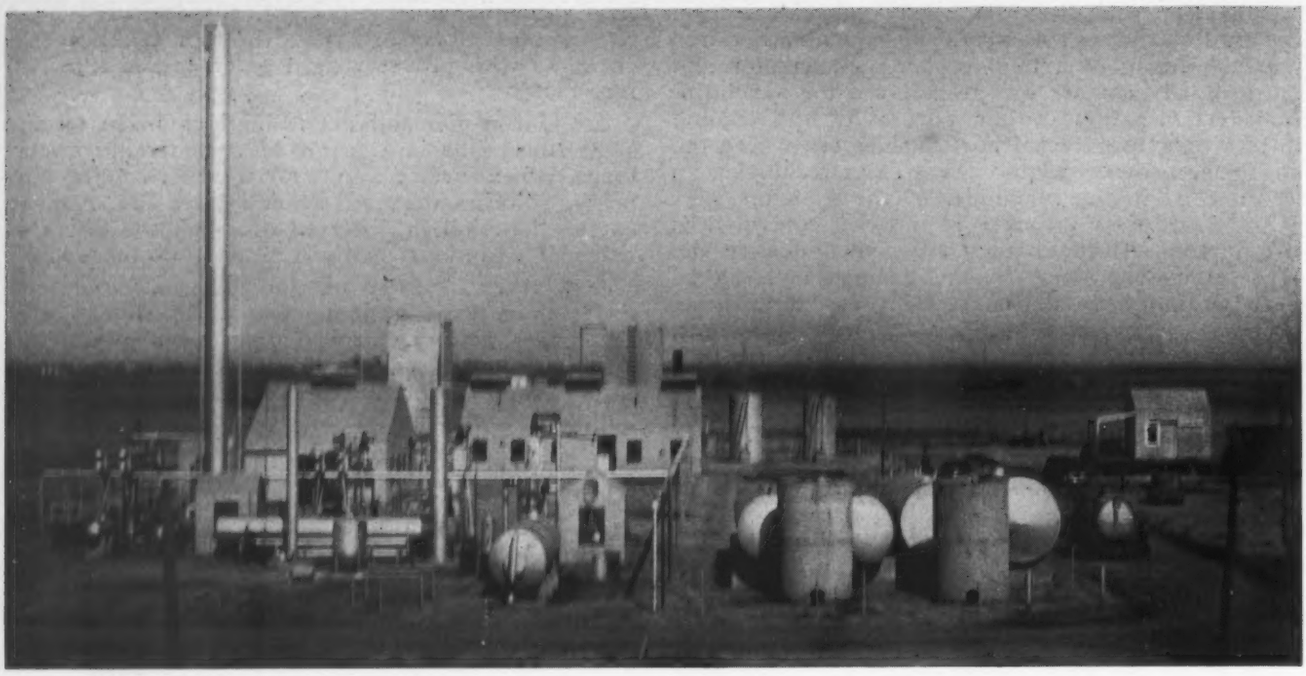
3. Chlorine demand determinations made on the spot, since time is a factor of considerable importance. When surface waters are used for cooling purposes, chlorine demands should be made over an extended period in order to establish the effect of seasonal variations on the character of the supply.

4. A careful survey of the physical features of the cooling water system must follow collection of the biological and chemical data, with special reference to flow rates, temperature changes, points of chlorine application, and the time element between the point of chlorination and the points where slime control is to be effected.

5. The foregoing data permits the selection of the proper chlorine-control equipment, after allowing ample factors of safety in the matter of reserve capacity. A hurried approach or selection of improper equipment, especially of a makeshift character, proves to be a false economy, leading to halfway or completely unsatisfactory results, with an attendant loss of appreciation of the possibilities associated with proper slime control methods.

Problems of chlorine control are definitely a phase of engineering. Selection of materials of construction, accurate metering, efficient application of the controlled gas, elimination of difficulties in handling a corrosive gas, the forestalling of hazards, the maintenance of equipment all demand a specialized knowledge.

6. The installation of the equipment and the inauguration of control processing should be preceded by the careful selection of the points to be used as a measure of the effects of chlorination. These will vary with the individual plant, and wide experience in the solution of similar problems is of vital importance in carrying these studies to final successful operation. Labor savings, lessened outage, fuel consumption, vacuum readings, quantity and quality output of the heat exchange units, screen cleanings, and general plant observation, all enable the experienced investigator to arrive at a conclusion as to the success in solving the sliming problem. In practically all cases conservative evaluation of these various factors will prove that investment in facilities for efficient slime control will be more than justified.



Gasoline Production and Repressuring Practice in the K-M-A Field

JOHN C. ALBRIGHT

DEEP Oil Development Company's gasoline plant, located north of Kemp City, is surrounded by some of the first deep wells completed in that section. Twenty-one wells are connected to the gathering system serving this plant, all of which are subject to proration.

All of the gas passing through this plant is taken from oil and gas separators instead of casingheads, with the separator pressure varying up to 10 pounds gauge, or more. Separators are installed on tall steel structures to afford sufficient gravity to allow oil to flow to stock tanks if and when the system is operated at atmospheric pressure. By obtaining raw gas at separator settings, extensive gathering lines are not necessary, but instead, heaters are used to drive off some of the lighter fractions of the oil to enrich the gas for greater gasoline production.

Adjacent to the plant on the west side, most of the wells on Deep Oil Development Company's lease flow into a double separator setting, with steam-heated exchangers installed directly in the flow lines to raise the temperature to that required. Steam for heating this oil is obtained from the gasoline plant boiler, transmitted through an insulated pipe line, partly buried, partly suspended overhead, and partly carried on low steel posts.

Exchangers heating the oil are square, inclosed units with tubes for oil passage, similar to equipment used in the plant as coolers for gas and for condensing overhead vapors from stills and fractionators. The exchangers are installed in adequate by-passes so that the oil can be routed around the units when atmospheric temperatures raise to a point where steaming will not be necesssary, and each works independently of the other, and each unit carries its own load of crude from the wells.

The installation used for heating fresh oil for higher gasoline production is almost automatic in operation, with temperature controllers admitting sufficient steam from the main transmission line to the exchangers to raise the temperature of the oil. Each exchanger is equipped with an individual controller, with the controlling diaphragm valve placed near the exchanger.

Oil flows more or less intermittently, as the wells are pinched back for constant production over a continuous period, and are reduced in daily production to conform to Sunday shut-down, so that gas can be obtained by the gasoline plant at all times. Condensate from the exchangers, caused by steam in contact with cold tubes in the unit, builds up to a pre-

determined level in the shells and is removed automatically by steam traps.

Flowing pressure from the wells is maintained on the exchangers without reduction, and the traps, or separators operate on the same pressure. Reduction in pressure is obtained in each gas line from the separators with automatic regulators in the line beneath the separator supports, and again with weighted lever regulators in the lines where they join the main gathering line leading to the plant intake scrubber.

No attendant is required to visit these separator settings oftener than twice daily, as excess pressure is released through safety valves, and temperatures are controlled within two or three degrees by instruments in the steam lines. So long as oil flows from a group of wells connected to a common separator or battery of separators, gas will flow to the gathering system under pressures comparable to the intake of the engines in the plant.

Inside the plant yard the single field scrubber prevents moisture and possible oil carried over with the gas from entering the compressor cylinders. The average pressure on the scrubber is about 7 pounds but varies between 5 and 10 pounds during the day. Fluctuation is small as each well produces its daily allowable spread about even over the full 24 hours, instead of by heads.

Since most of the gas is received in the plant at elevated temperatures, due to steaming the oil in exchangers to reduce the gravity slightly, coolers are installed on the low-pressure cylinder suction line to cool the volume of gas as much as possible. Due to abrupt change in temperature, there is some condensation to gasoline, and this is caught in an accumulator tank through which all the cooled gas must flow before it enters the compressor. A box-type shell-and-tube exchanger is used for cooling, with gas and water flowing counter-current. Gas and condensate leave the exchanger through the bottom end and immediately pass into the vertical accumulator, which is 36 inches by 8 feet 9 inches, welded and shipped intact from the factory.

The low-pressure cylinder on the engine receives the gas at from 5 to 7 pounds intake, and boosts it to 50 pounds after which it flows back to the distillation equipment for intermediate cooling. A square shell-and-tube unit is used for this stage of cooling, which is operated exactly like the intake

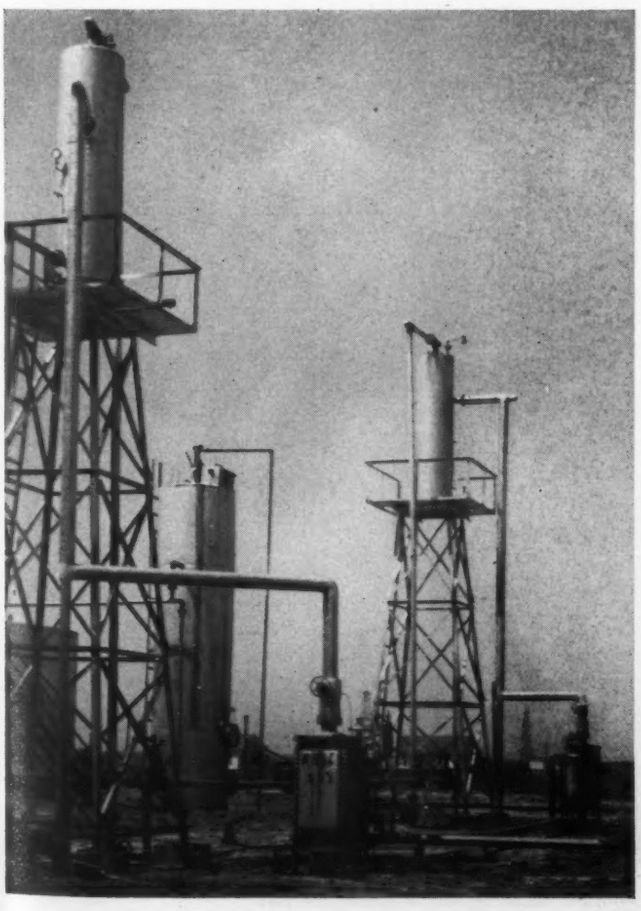
NOVEMBER 10, 1919, saw a scramble for leases in Wichita County, Texas, when K-M-A Oil Company drilled a well flowing 300 barrels of high-gravity oil the first day. Oil then was selling for $3.50 per barrel with a "two-bit" premium paid by refiners and pipe line companies, and with local "economics" in such shape that $100 bills were so common that stores were burdened with large supplies of dangerous or endangered cash for making change. Leases in the vicinity of the discovery sold as high as $10,000 per acre—until the bottom dropped out.

This field was developed in later years with small wells drilled to sands from "post hole" depth to as deep as 1700 feet in some locations. Proration was unheard of, save when pipe line companies refused to run more than a declared amount in 1923. However, the area was good for a wildcat operation now and then, and many small producers made a little money. The gas volume produced with the oil was too small from the individual well to justify a gasoline plant, but the gas was rich and many barrels were condensed in drips and used by oil lease workers.

Twelve years, five months and two days after the initial boom was started, a well was completed in this same area in search of deep production. This well was small and caused merely a mild flurry among local oil men. However, Deep Oil Development Company continued to put down wells to the 3000- and 3800-foot zone for relatively small production. Other companies came into the area, but it required a couple of completions over a wide area to set off the spark which may bring about the uncovering of an oil and gas producing area which may rival the giant in East Texas.

The gas produced in the K-M-A field as it is now processed has a gasoline content of two to three gallons per thousand cubic feet in the "lime" area and it is produced in sufficient volume to justify gasoline plant installation.

At the time of preparation of the accompanying description of the Deep Oil Development Company's plant, this company was operating the pioneer gasoline plant for the area, handling about 1,100,000 cubic feet of gas daily. Two other plants were building, one southwest of Kemp City, which is a joint project of Phillips Petroleum Company and Sunray Oil Company, and another north of Big Wichita River by Continental Oil Company. The present operating plant and the two plants building are to be used as combination plants, processing the rich natural gas for natural gasoline and boosting the residue gas to sufficient pressure to maintain reservoir pressure on the producing horizons.



Battery of separators operated by Deep Oil Development Company, K-M-A field, through which all oil is passed for gas separation. Heaters on ground are used to raise temperature of oil so larger volumes of gas will be available for gasoline extraction.

cooler, and installed above an accumulator tank to receive condensate coming from the gas.

Returned to the engine a second time, the gas is compressed to about 350 pounds and cooled outside in longitudinal sections with water flowing through to reduce the temperature. These coolers are constructed of 6-inch piping with two turns of 2-inch pipe placed inside, packed off at the outlet to prevent water leaks and with floating heads to compensate for contraction and expansion. The bulk of gasoline is extracted in this cooler and under the intermediate pressure of 350 pounds, but the gas is subjected to a third compressing which raises the pressure to 1100 pounds gauge.

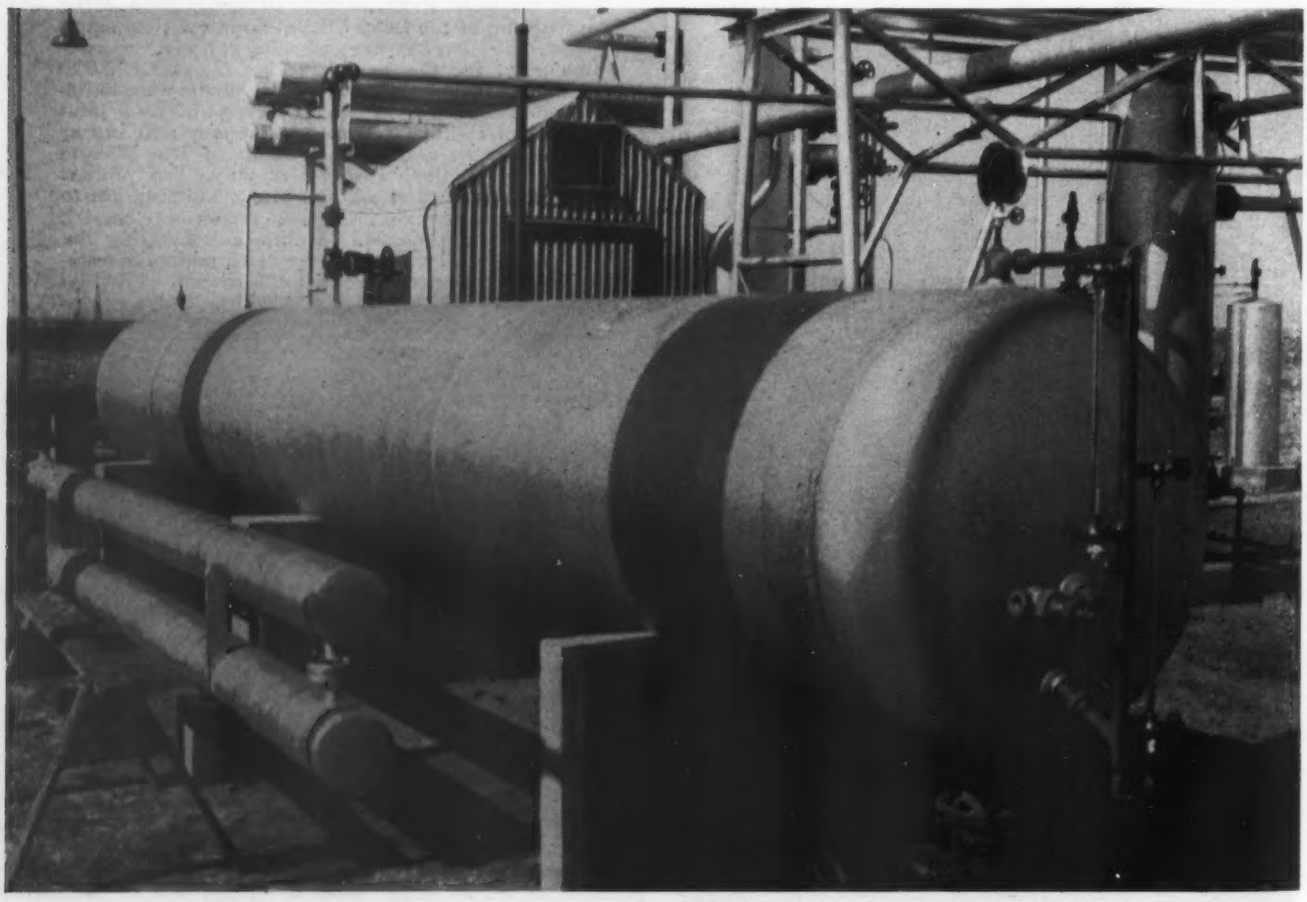
The intermediate and high-pressure system in the twin-cylinder gas engine, having tandem cylinders on intake and intermediate compression, are protected by relief valves installed at the logical points, and with forged steel gates and fittings on the high-pressure side. No cast iron is used in the engine room, steel and malleable predominating. The engine is protected further with mercury switches which make the engine inoperative when excess pressures or temperatures occur.

Gasoline condensed under the various pressure stages in the plant is handled by pumps, except that which is condensed in the intermediate coolers. This is confined under sufficient pressure to route it to the stabilizer under accumulator pressure. Liquid-level controllers are installed on both the low-pressure accumulator and the intake cooler receiver which permit fluid to pass outward as it fills in the tanks. Lines lead to a reciprocating steam pump that delivers the gasoline to the intermediate pressure scrubber for blending before stabilizing. This system is almost automatic, and requires only an occasional visit by the operator.

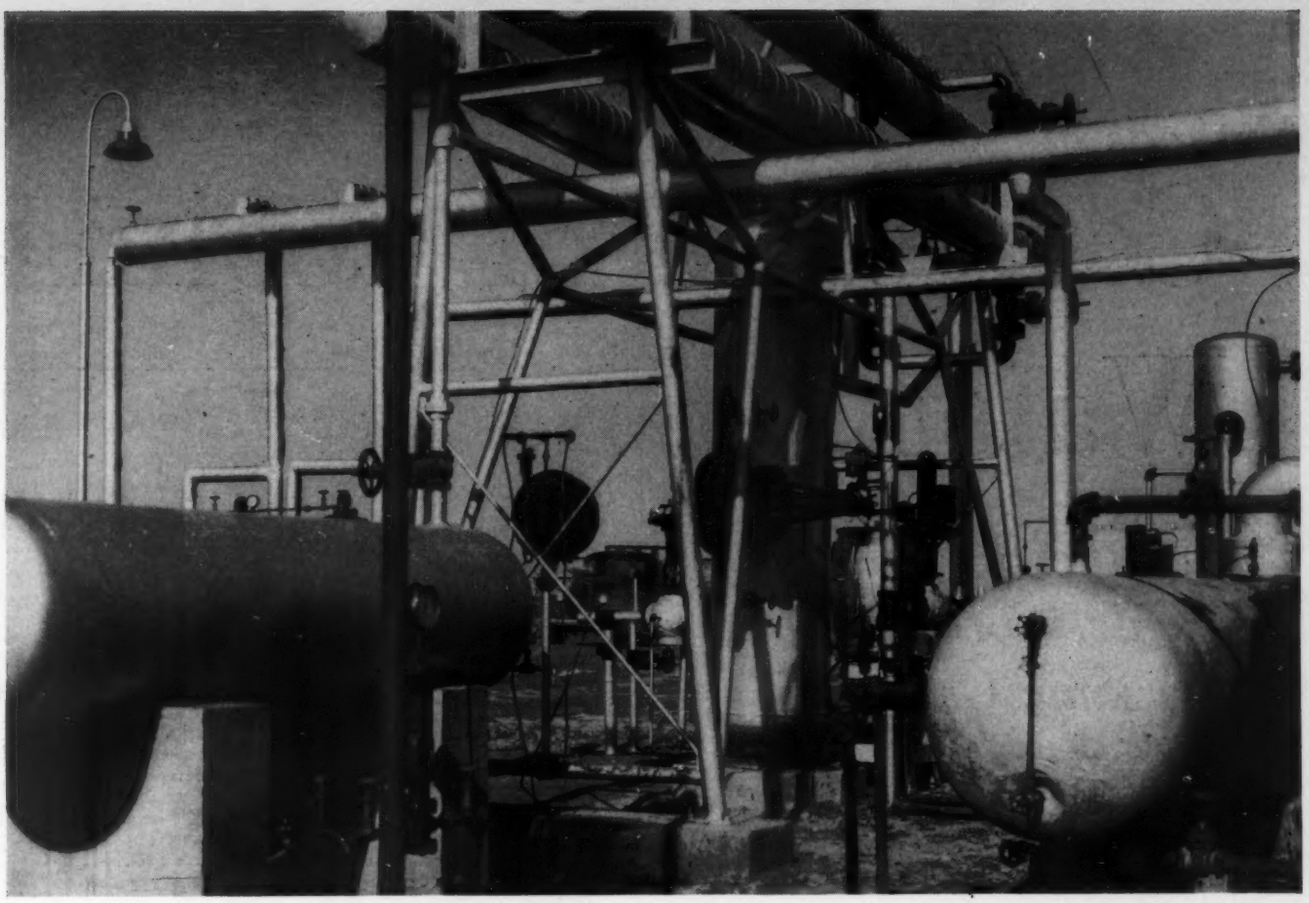
All production made in the plant is stabilized to definite vapor pressures in a common column. This tower is somewhat unusual, insofar as the interior is concerned and is 30 inches in diameter and 66 feet 9 inches in height. The column has 30 trays, each of which is fitted with 24 bubble caps, hexagonal, and 4 inches in dimensions. A reboiler, 24 inches O. D. by 14 feet long is attached to the column for obtaining desired temperatures on the base material in the column.

The charge pump, controlled by an instrument combined with a liquid-level controller, pumps the gasoline as supplied to the column after it flows through a gasoline-to-charge exchanger for heating. The pressure on the column is maintained at about 150 pounds, gauge, when manufacturing 14-pound gasoline, and the reboiler temperature held constant at 278°F. Bottom product sometimes is made with a vapor pressure of 26 pounds, Reid, depending upon market requirements.

The raw feed to the column averages about 6,500 gallons per day when steaming crude oil in the separator settings, and when approximately 1,100,000 cubic feet of gas is processed. The direct-reading flow meters indicate that the stabilizer charge rate runs on an average of 4.5 gallons per minute, which is controlled as to vapor pressure by the pressure and temperature on the column, and the reflux rate of 4.25 gallons per minute pumped back over the column. Approximately 2,400 gallons of the 6,500 gallons of raw compression gasoline is recovered as



Butane storage vessel and gasoline intercoolers showing installation method.



Stabilizer reflux drum shown at left with reboiler on right and reflux condensers overhead.

14-pound product, with the lighter product, comprised principally of butane and propane, passing overhead to field fuel lines.

The overhead-vapor stream is carried to condensers, similar in design to the intermediate-pressure gas coolers, where part of it is liquefied and caught in a vertical accumulator. Part of this liquid is transferred automatically by gravity to a second vessel from which it is pumped to the column for overhead control. Two single-cylinder steam pumps are set for reflux control, automatic in action and varying in volume in direct proportion to the raw feed to the stabilizer.

The stabilizer is equipped with four nipples attached to the fourth, sixth, eighth and tenth plate—from top to bottom—which may be used for butane removal, or a product which may be used in internal combustion engines for drilling and other purposes, composed of a mixture of butane and propane. Facilities for butane accumulation are installed in the plant, and consist of a horizontal vessel, 42 inches by 30 feet, placed on concrete cradles near the stabilizer. Experiments are now being conducted with butane withdrawal from the top nipple in the column, placed at the fourth bubble plate, but sufficient data are not accumulated to definitely prove that this practice can be followed successfully.

Gasoline is stored in horizontal tanks. A considerable portion of the 14-pound natural is converted into motor fuel for stationary engines and the like, by blending at the plant with 400 end point naphtha. Blending is accomplished while the gasoline is in transit from the reboiler to coolers, and is what the operators call "hot" blending.

Naphtha, or blending stock, is secured from refineries in trucking distance and stored in pressure tanks near the gasoline tanks. From these tanks the naphtha is pumped at a predetermined rate to the outlet of the reboiler to mix in controlled volumes with hot gasoline as it is stabilized. No special mixing head is used, and the naphtha and gasoline blend through a common connection, depending upon turbulence occurring in a tee and piping in transit through the plant.

Upon being blended, this motor fuel passes through the stabilizer charge heat exchanger and thence to atmospheric coolers in the water tower. Passing back to the stabilizer, the pressure is released to that required in storage by an automatic regulator. This is operated by the reboiler liquid-level controller, and when the proportion of naphtha to natural is established, the flow is automatic and requires only occasional adjustment.

Gas which is not required for plant consumption after extracting the available natural gasoline, having been compressed to 1,100 pounds gauge in the third-stage cylinder, is returned to the oil producing horizon. This practice is one that has been decided upon by a majority of oil companies in the field, and will, to a large extent determine the practices of the new plants contemplated and in course of construction. While not a gasoline plant problem, compression to high pressures will be handled by gasoline plant engine rooms, and will, therefore, come under gasoline plant operation and management.

Water for this plant is secured from wells drilled on the property which furnish an ample supply, but the mineral content is high, and scaling is quite a factor. All water, for boiler use and that consumed in cooling towers, is treated before use. The water is lifted by air-lift, with air compressed in the auxiliary room by a small two-cylinder compressor operating from a line shaft, which in turn is driven by a multi-cylinder gas engine.

Methods of Correction of Cooling Water . . .

for the Prevention of Scale, Corrosion and Organic Growths

L. D. BETZ

Mr. Betz is a member of the firm of W. H. and L. D. Betz, chemical engineers of Philadelphia, Pennsylvania, and has specialized in colloidal chemistry particularly in its application to the refining industry. He is a graduate of Drexel Institute of Technology and author of many papers on colloidal chemistry presented before chemical and technical societies.

The accompanying paper was read before the technical session of the Twenty-sixth Annual Meeting of the Western Petroleum Refiners Association, Hot Springs, Arkansas, April 25-27, 1938.

THE presence of impurities in water and the correction from their deleterious effects has long been a problem of major importance to industry as a whole, to which the petroleum refiner has been no exception. Such problems, in the petroleum industry, divide themselves into two distinct classes, namely—the conditioning of water for evaporation purposes on the one hand, and the correction of water for cooling purposes.

Time being limited, it is necessary that we confine our remarks in this discussion to cooling waters entirely, although the solution of the water problems in any one plant cannot be found by arriving at a method best suited for the treatment of cooling waters, without giving careful thought to boiler water as well, and vice versa, as the two problems are intimately associated.

In order to give intelligent thought to the best suited method of correcting any water, it is necessary that we first understand thoroughly what impurities are present, and what difficulties these impurities cause.

Chemically-pure water has the formula of H_2O, a formula common to every high school student of first-year chemistry. Unfortunately, however, chemically-pure water is never found in nature. Water reaches the earth in the form of rain or snow. In falling through the atmosphere, it picks up many gases, such as carbon dioxide, sulfur dioxide and oxygen, which cause it to become acidic in character, and which in turn cause it to effect a dissolving action on the rocks with which it comes in intimate contact in its travels, while on or in the earth's surface. It is the presence of these products which cause the major difficulties in water, regardless of whether the water be used for cooling or for evaporation purposes.

An examination of a list of the salts found as impurities in water reveal these to be chiefly the salts of calcium and magnesium, iron, silica and sodium, all of which come from the earth's mineral deposits. Other impurities are also frequently present, introduced as waste products. These include mineral acids, oils, sewage, etc.

It will be found that the presence of these impurities are the cause of three major difficulties, which are 1—scale depositions; 2—corrosion and 3—foaming, the latter of which is common only to boiler operations.

SCALE

Scale deposited on a metal surface greatly retards heat transfer, regardless of whether it is present in a boiler, or in a cooling system. Considerable study has been given to the insulating effect of scale and formulae developed for calculating the loss. While recent research has shown this loss to be less than previous estimates, nevertheless, it is a matter of considerable importance that such deposits be eliminated to provide for economic operation.

The presence of calcium bicarbonate is particularly undesirable in cooling waters, as this salt, upon the application of heat, breaks down to liberate calcium carbonate, carbon dioxide and water, the calcium carbonate being insoluble and depositing on the metal surface. The reaction involved is as follows:

$$CaH(CO_3)_2 + \text{Heat} = Ca\,CO_3 + CO_2 + H_2O$$

A study of the composition of many types of scale reveals that the calcium salts exist in various petrographic forms. For example, three distinct petrographic forms of calcium sulfate are known to exist. Gypsum, calcium sulfate containing two molecules of water of crystallization forms at atmospheric pres-

sure; hemihydrate, containing ½ molecule water forms at pressures from 15 to 50 pounds while anhydrite, with no moisture of crystallization, forms at pressures above 50 pounds. All three forms possess different solubilities. Calcium carbonate exists in two different petrographic forms, namely—calcite and aragonite.

All scale-forming calcium salts possess inverse solubility ratios; namely—they are more soluble at lower temperatures than at higher temperatures. This is more pronounced in the various forms of calcium sulfate than for calcium carbonate, chiefly because of the higher solubility of the former salt. Calcium carbonate is very insoluble, while calcium sulfate will remain soluble to the extent of 1600 p.p.m. very safely at temperatures encountered in cooling operations. It is this fact on which we base the sulfuric-acid treatment of cooling water, on which we will dwell more extensively at a later period.

The following is a typical analysis of a sample of scale removed from a cooling water system:

	Percent
Calcium Oxide as Ca O	49.79
Magnesium Oxide as Mg O	2.42
Iron and Aluminum Oxide as R_2O_3	0.82
Organic Matter and Oil	6.05
Carbon Dioxide as CO_2	39.00
Sulfur Trioxide as SO_3	1.29
Silica as Si O_2	0.15
Thickness from ½" to 3"	..

From the analysis given, it is plainly seen that this scale is composed of approximately 89 percent calcium carbonate, the balance being organic matter and oil together with very small quantities magnesium hydrate sodium sulfate, iron, aluminum and silica. Naturally, it is not intended to imply that every sample of scale from cooling waters will analyze the same as the example shown, for just as the dissolved salts in water vary, so do the component parts of the scale formed vary in a similar manner. It is for this reason that a thorough study must be made of each case individually to determine the most satisfactory manner to meet the problem.

CORROSION

The problem of corrosion on the water side of equipment has long been one of major importance to the petroleum refiner. Cooling waters, coming as they do in intimate contact with iron or other metal surfaces, exert a dissolving action, thus placing the metal in solution resulting in a wasting away of the metal itself. In considering the problem of corrosion, it is just as well that we consider the accepted theory of this peculiar action, as advanced by Speller.

The element iron, like all other metals, when placed in contact with water or a solution, has an inherent tendency to go into solution in the form of electrically-charged particles, called ions, but since the solution must remain electrically neutral, these positive ions can enter the solution only if an equivalent number of positive ions of some other element are somehow displaced. In the case of pure water in contact with iron, hydrogen ions are plated out at the interface. This reaction may be written as follows:

$$\underset{\text{Metal}}{Fe^{\circ}} + \underset{\text{Ions}}{2H^{+}} = \underset{\text{Ion}}{Fe^{++}} + \underset{\text{Atoms}}{2H^{\circ}}$$

The hydrogen, liberated in this reaction, forms a thin invisible film on the iron surface, which may possibly obstruct further progress of the reaction in two ways: first, by insulating or separating the iron from the solution, and secondly, by an increasing tendency on the part of the hydrogen in the film to re-enter the solution. thus opposing the tendency to corrode. It is possible that in many neutral waters this may become so effective as to stop corrosion before it has proceeded to any great extent. One can readily see however, that the destruction of the hydrogen film will permit corrosion to proceed. Unfortunately, this film can be readily destroyed in either of two manners: the hydrogen can combine with oxygen in solution to form water, or it may escape in the form of bubbles, as hydrogen gas. In either case, the removal of the hydrogen film permits the original reaction to again proceed. More iron goes into solution and more hydrogen plates out and this process continues at a rate which is mainly determined by the rate at which the film of hydrogen is destroyed. From this theory, one can readily determine the part played by the presence of dissolved oxygen in water and its effect on corrosion, for the more dissolved oxygen that is present, the more readily the hydrogen film will be destroyed and the more rapid the rate of corrosion. One can also readily understand from this theory, how turbulence, temperature and salts in solution all play an important part in the rate of corrosion, by aiding in the destruction of the hydrogen film. Cooling waters, are usually fully aerated, contain large amounts of dissolved oxygen, are continuously in motion, receive considerable input of heat units, thus changing the temperature frequently and often contain large amounts of salts in solution. All of these things, as has been shown, have a destructive action on the hydrogen film and readily accounts for the high rate of corrosion encountered in cooling-water systems, unless some steps are taken to inhibit corrosion.

Even in the absence of oxygen, the hydrogen film can be destroyed by the evolution of hydrogen. The liberated hydrogen leaves behind the oxygen with which it originally was combined in the form of water, to continue the corrosion reaction, the second step of which is to form ferrous hydroxide shown in the following reaction:

$$Fe^{++} + 2(OH) = Fe(OH)_2$$

A saturated solution of ferrous hydroxide in distilled water has a pH value of 9.6, which readily explains how the pH value of water can be raised to this figure through the process of corrosion and will also explain how additional corrosion may be retarded when reaching this pH value, it being due to the fact that a saturated solution of ferrous hydroxide has been reached.

The third and final step in the process of corrosion is the further oxidation of the ferrous hydroxide to its ferric salt only to end up with ferric oxide, the familiar iron rust.

The presence of magnesium chloride in any appreciable quantities in water, in which heat is introduced, such as accomplished in a cooling water system, also sets up a corrosive action. This is what is known as a cyclic reaction, in which the end product of the reaction is the same as that at the beginning, thus accounting for a large amount of corrosion from the presence of but a small amount of the salt.

In these reactions, magnesium chloride first combines with the water to form magnesium hydroxide and hydrochloric acid.

$$MgCl_2 + 2\,H_2O = Mg(OH)_2 + 2\,HCL$$

In the second reaction the hydrochloric acid

formed, attacks the iron forming ferrous chloride, thus:

$$Fe + 2\,HCL = FeCl_2 + H_2$$

The ferrous chloride formed in the second reaction is further reacted upon by the magnesium hydroxide from the first reaction to form ferrous hydroxide and magnesium chloride as shown in the following reaction:

$$FeCl_2 + Mg(OH)_2 = Fe(OH)_2 + MgCl_2$$

Notice that the final products of these reactions are the products of corrosion ($Fe(OH)_2$) and magnesium chloride, the very salt with which we started, which again proceeds with the same reaction, on and on.

ALGAE CONTROL IN COOLING WATERS

Another problem which frequently is the cause of considerable trouble in cooling-water systems is the control of organic microscopic organisms. It is necessary to control or destroy these growths as they are frequently the cause of costly repairs and high maintenance.

In this discussion, we are referring to the microscopic plants and animals commonly classed as algae and not to the pathogenic bacteria whose elimination is absolutely essential for sanitary purification of water. The presence of algae in water is very troublesome in laundries—causing discolored clothes, in dye-houses where interference with uniform dyeing is encountered; in paper mills, where difficulties in the white-water systems are encountered and in numerous other industrial enterprises.

Algae in cooling water systems is indirectly responsible for many internal combustion engine failures through clogged cooling systems. In refinery cooling systems, they cause difficulty through impaired heat transfer and poor temperature control.

Algae are classified under several different headings. Several different genera are illustrated in the following slides:

The first is an example of a Diatomaceae, illustrating the species Asterionella. Two illustrations of this are shown—one before treatment and the other after treatment with copper sulphate. Two illustrations are shown of the chlorophyceae. The species shown are the Spirogyra and the Volvox. The Protozoa are illustrated by the Synura and the Uroglena. Both of these species are common inhabitants of surface waters, the Synura is particularly noted for its odor, which is similar to that of a cucumber and for its bitter taste. Uroglena has an odor similar to that of cod liver oil and is commonly found in surface waters. It is one of the easiest organisms to kill by treatment. Crustacea, which are animals, are illustrated by the Cyclops and the Daphnia. I am indebted to Dr. Hale of the New York Department of Water Supply for the use of these photomicrographs.

Occasionally, well waters containing iron and manganese, contain algae such as Crenothrix and associated forms, which cause trouble from clogged pipes, but generally these troublesome organisms occur chiefly in surface waters. Litteral growths, attached to the banks or the bottom of reservoirs, rarely cause trouble, unless they become detached or decayed.

The algae appears first as small greenish patches on the surface of the water, in those spots which are not affected by wind or current. They grow and propogate very rapidly under favorable conditions of sunlight, temperature and air. The slimy masses cover the surface ot the water, prevent evaporation or radiation from the surface and so increase the temperature of the water below. As the growth progresses, these masses are drawn into suction lines, clog valve ports of the suction pumps and seriously decrease the flow of water through a cooling system.

With regard to the seasonal prevalence, temperature is probably the determining factor, especially as to the time of starting up of growth. Once these growths are started, certain species may proceed under colder temperatures. Diatoms usually appear in the spring and fall. Cyanophyceae appear in the summer and fall and Synura and Uroglena, which are two of the most objectionable varieties, prefer cold temperature and even grow under ice.

It is useless to attempt to skim the masses of algae from the surface of a cooling pond, for it is impossible to remove all of the growths by this method and the residual colonies left will soon spread until original conditions are prevalent. Furthermore, it is possible to contaminate even a sterile supply of water, for the organisms may be carried by the wind from sources of contamination such as marshes which may be located near the ponds.

Several chemical agents are effective in killing algae and a considerable amount of experimental work has been done. Copper sulphate, chlorine and ammonia (chloramine process) have both been used successfully. The United States Department of Agriculture has done extensive research work on the control and elimination of algae growth and have recommended the use of copper sulphate primarily because it is inexpensive and requires no elaborate feeding equipment and is not hazardous to the workmen. They have also found that the different species varv widely in their reaction to the controlling agent. By far the majority of the organisms are killed by the application of a fraction of a p.p.m. of copper sulphate. For example, Uroglena is destroyed by 0.2 p.p.m. while Beggiatoa requires 5 p.p.m. and some Chlorophyceae such as Eudorina or Pandorina require 10 p.p.m. Since the average engineer and even many chemists are unable to determine the exact specie or species of algae present, the only safe procedure to adopt is to assume that the most resistant organisms are present and to treat the water accordingly. Certain isolated species of Crustacea, such as Cypras and Daphnia are very resistant to copper sulphate treatment and chlorine treatment is suggested for their removal. It has been found that 10 p.p.m. of copper sulphate will kill bacillus coli. Kellerman, reporting in Bulletin No. 100—1906 of the Department of Agriculture listed the quantities of copper sulphate required for treatment of different genera.

The dose of copper sulphate should be increased or decreased 2.5 percent for each degree Centigrade, if the water temperature is above or below 15°C. The amount of copper sulphate used must be increased when organic matter is present in the water to be treated. A 2 percent increase is specified for each 10 p.p.m. of organic matter in the water. The amount used must also be increased over the base amount specified if the alkalinity of the water is high, as copper sulphate is precipitated in alkaline solutions as copper carbonate or copper hydroxide. Organic matter also tends to precipitate copper.

Chlorine and chloramine are used extensively in paper industries for the prevention of algae slime, in their white-water systems. The use of these treatments is not recommended for cooling water installa-

tions except in isolated cases where species of algae, very resistant to copper sulphate treatment are encountered, because of the cost of the chemicals as well as the cost of the feeding equipment, attendant to the use of chlorine and ammonia.

While we are not primarily interested in the use of chlorine or chloramine treatment for refinery problems, the method is very meritorious and is of sufficient interest to discuss briefly at this time. One of the principal difficulties in connection with the chlorine sterilization of water, particularly of white-water systems in pulp and paper mills, has been the rapid dissipation of the chlorine, so that although relatively complete sterilization has been obtained at or immediately following the point of application, aftergrowths of bacteria or algae have developed to such an extent that the algae slime has not been satisfactorily controlled. The use of the chlorine-ammonia treatment has largely overcome this difficulty. It has been noted that there is a definite delay in the disinfecting properties where ammonia is used, although the final efficiency of the combined agent is as great or greater than when chlorine is used alone. Studies which have been made on this subject, show that when chlorine alone is used, about 99 percent of the bacteria is removed in 15 minutes. Due to rapid combination of the chlorine with organic matter in the water however, this efficiency is soon dissipated. If 0.1 p.p.m. of ammonia is added to the same quantity of chlorine, the same efficiency is not obtained until 1½ to 2 hours. If the amount of ammonia is increased to 0.3 p.p.m., using the same amount of chlorine, the maximum point of efficiency is not reached until three hours after addition of the treatment. In certain instances, this delayed reaction is definitely beneficial.

Chloramine exists in three forms—as mono-di- and tri-chloramine. Tri-chloramine or nitrogen tri-chloride is stable at a pH value of 4.4 or less. As the pH value increases, there is a gradual shifting equilibrium in which di- and mono-chloramine exists; 100 percent mono-chloramine being produced at a pH value of 8.5. Under usual conditions, the ammonia and chlorine are present in the water as mono-chloramine. Theoretically, 1 part of ammonia is required for each 4 parts of chlorine and these ratios should be respected in feeding the treatment.

One manner of applying copper sulphate treatment to large ponds is to drag a series of burlap bags, each containing about 50 pounds of the chemical, through the water by means of rowboats, taking a zigzag course, so as to triangulate the surface of the water. The wind, waves, diffusion, and gravity, mix the streaks of treated water with the remainder. While this method seems very crude, it has been reported to be quite successful and has been used in the treatment of numerous municipal water supplies for a number of years. However, Elton Sterrett has reported in the March, 1938, issue of "Power Plant Engineering" that greatly improved results were obtained by mixing the required quantity of chemicals in a small volume of water and spraying the copper sulphate solution over the surface of the pond. It was reported that the surface of the water was free from algae scum in approximately one third the time required by the other methods. Other experiments were made which showed that a considerable reduction in quantity of treatment required, could be made if a hot solution was sprayed on the surface. When the solution temperature was 80° higher than that of the reservoir water, the amount of copper sulphate required for sterilization was only a third of the amount formerly used.

Algae are surface growths and the entire mass of organisms is confined to the upper layer of water in a pond. Concentrations of algae decrease rapidly, as samples are taken at greater depths in the pond.

With the foregoing facts in mind, it is evident that surface application of the treatment is highly desirable. It is also evident that the quantity of treatment should be based on the volume of water occupying the upper strata of the pond rather than to waste treatment on the uncontaminated lower strata. Sterrett also reports that experiments were made to determine if the copper sulphate solution, which has a heavier specific gravity than water, would settle to the bottom of the reservoir, thereby diluting the treatment below its effective point. Results were obtained which showed that after 24 hours, the concentration remained stronger at the surface, decreasing gradually with depth, until the bottom concentration was less than one fifth of that found at the surface.

It is also recommended that in the case of pond surge tanks or reservoirs, that the walls and bottom of the tank be thoroughly scrubbed between drainings, with a stiff broom, dipped in a 1 percent solution of copper sulphate. This procedure permits a thorough treatment of the scum left on the interstices of the walls as the tank is drained.

Sterrett reports that sodium di-chromate is also effective against algae, but is not as effective as copper sulphate, for sterilization purposes. It is sufficiently effective, however, to keep the growth of algae from becoming very objectionable, but is considerably more expensive than copper sulphate. Since copper sulphate is poisonous to animal life, care should be used in discharging waste or sludge from the reservoir into rivers to see that there is ample dilution to reduce the copper content below the danger point.

Recent development of several synthetic organic chemicals have shown promise of becoming of considerable value in controlling algae growths. Sodium pentachlorophenate has been found even toxic to chlorine and copper-resisting organisms and appears to offer considerable promise as an industrial algacide. Additional information on this should be available shortly.

METHODS OF CORRECTION FOR SCALE AND CORROSION

We have, up to the present, in this paper, shown the main causes for scale depositions and corrosion, and in discussing algae, have given methods of its control. There remains but to outline the methods of control for scale and corrosion, keeping in mind the break-down of calcium bicarbonate as the chief factor in scaling of cooling systems, in the reaction shown.

Three methods can be employed in treatment of water of this character. They are:

a—Lime treatment—possibly coupled with soda ash.

b—Zeolite treatment.

c—Sulfuric acid and aeration.

The choice of which of these methods to employ in any given instance will be dependent upon the character of the water, determined from analysis and a careful study of the particular mechanical and cooling conditions at the plant, taking into consideration the economics involved. Through only such a

careful study can definite recommendations be determined. What may be suited to one plant and one type of water may be entirely unsuited to any other.

The treatment with lime is based on the following reactions with calcium bicarbonate:

$$Ca\,H(CO_3)_2 + Ca\,(OH)_2 = 2\,CaCO_3 + 2\,H_2O$$

The calcium carbonate formed in this reaction is an insoluble salt which is either permitted to settle out of solution by retention, or removed by filtration.

In the use of Zeolites, the following reaction is involved:

$$CaH(CO_3)_2 + Na_2Z = 2\,Na\,H\,CO_3 + Ca\,Z$$

in which the calcium ion has been replaced by the sodium ion in the base exchange process.

The sulfuric acid-aeration treatment is one we have employed very successfully, especially in the Mid-Continent field, and is based on the following reactions.

$$Ca\,H(CO_3)_2 + H_2SO_4 = Ca\,SO_4 + 2\,CO_2 + 2\,H_2O$$

In this reaction, the bicarbonate ion is destroyed and is replaced with the sulfate ion, carbon dioxide being liberated in the process. With calcium sulfate posesssing a much greater solubility than calcium carbonate, considerably higher concentrations can be carried without the danger of being thrown out of solution, or of being deposited on heat-exchange surfaces. Opportunity should be afforded for the release of the carbon dioxide liberated in this reaction and a small aeration chamber should therefore be provided for this purpose.

The use of reactive colloids in either the lime pretreatment system or the sulfuric acid system, materially increases the beneficial results and provides a means of lowering the total cost of treatment.

In the following table, I have listed an average water analysis from a plant in the Mid-Continent field and have shown the expected analysis after treating this water by the three systems mentioned. These calculations have been made from a theoretical standpoint, merely to illustrate the reactions involved. The analysis shown for the lime-treated water is based on complete precipitations of the carbonate hardness and no allowance has been made for the precipitation of the magnesium content. Af course, in practice, it is impossible to treat water for the removal of carbonate hardness alone, without also removing a portion of the magnesium. It is also necessary to employ excess quantities to force reactions to completion. The figures given are therefore lower than can actually be obtained in practice.

Composite Raw Water

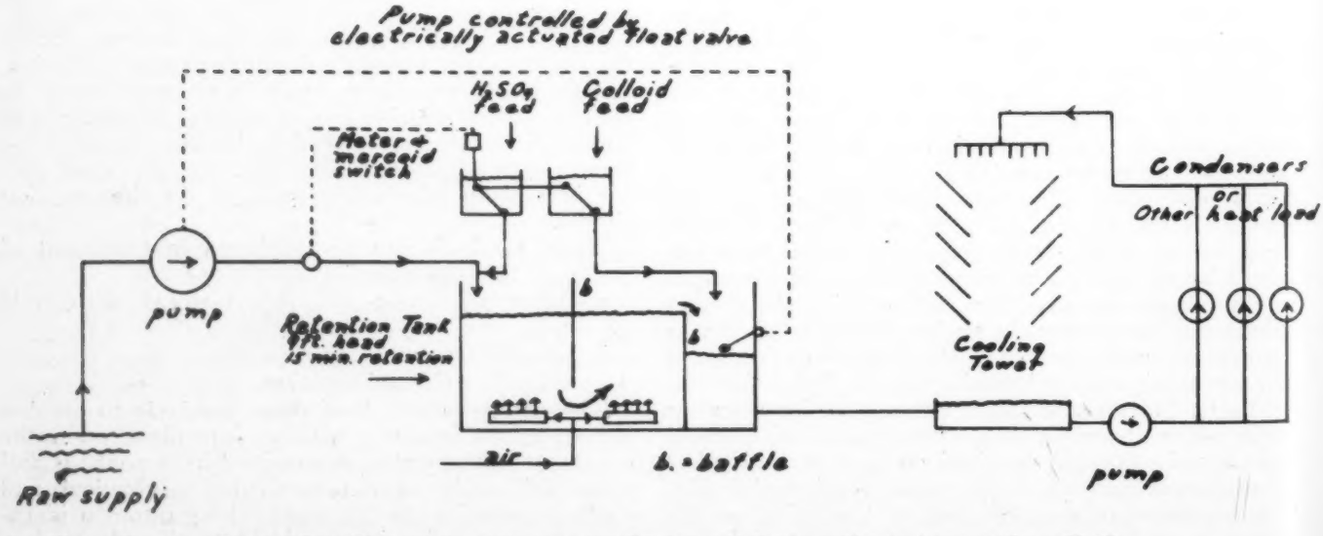
	Max.	Min.	Aver.	A	B	C	D
Silica (SiO_2)	21	13	16	16	16	16	40
Iron and Aluminum Oxide (R_2O_3)	10	2	5	.....	.....	.....	.....
Calcium (Ca)	179	113	134	134	54	0	335
Magnesium (Mg)	39	16	31	31	31	0	77
Sodium (Na)	493	315	405	405	405	617	1012
Bicarbonate (HCO_3)	283	187	242	49	0	49	123
Carbonate (CO_3)	0	0	0	0	0	0	0
Hydrate (OH)	0	0	0	0	0	0	0
Chloride (Cl)	813	474	649	649	649	649	1620
Sulfates (SO_4)	360	143	217	370	217	217	925
Volatile and Organic Matter	56	20	40	.....	.....	.....	.....
Hardness as $CaCO_3$)	607	396	460	460	264	0	1150

A—Expected analysis after sulfuric acid treatment.
B—Expected analysis after lime treatment. (See text).
C—Expected analysis after zeolite treatment.
D—Expected analysis of circulated water, acid treated, under normal concentrations in the system.
Results in p.p.m.

From the subject matter presented in this brief discussion, it is evident that the problems encountered in the treatment of cooling waters may vary widely in their complexity and in the method of solution. There is an ample amount of technical knowledge available to cope with almost any cooling-water problem. It is not advisable for inexperienced operators to attempt to handle these problems for frequently misguided experiments result in costly repairs to the equipment.

Therefore, I want to again impress you with the importance of a thorough and complete study of the individual problem involved by competent engineers before the adoption of any method of correction.

The author wishes to acknowledge the assistance of Mr. E. M. Ross of the chemical staff of W. H. and L. D. Betz, for helpful assistance in assembling some of the data used in this paper.



Proposed cooling water treatment, employing sulphuric acid-aeration-reactive colloids.

True Vapor Phase Process

FRANK PRAEGER
Alcorn Combustion Company

Mr. Praeger is a native of Texas but his position as sales manager of Alcorn Combustion Company of Philadelphia takes him into every oil refining district in the country. He was graduated from the University of Pennsylvania as a mechanical engineer. Since 1926 he has been associated with Alcorn Combustion Company as a salesman-engineer, and was in charge of the company's first branch offices in Tulsa and later in Los Angeles and San Francisco.

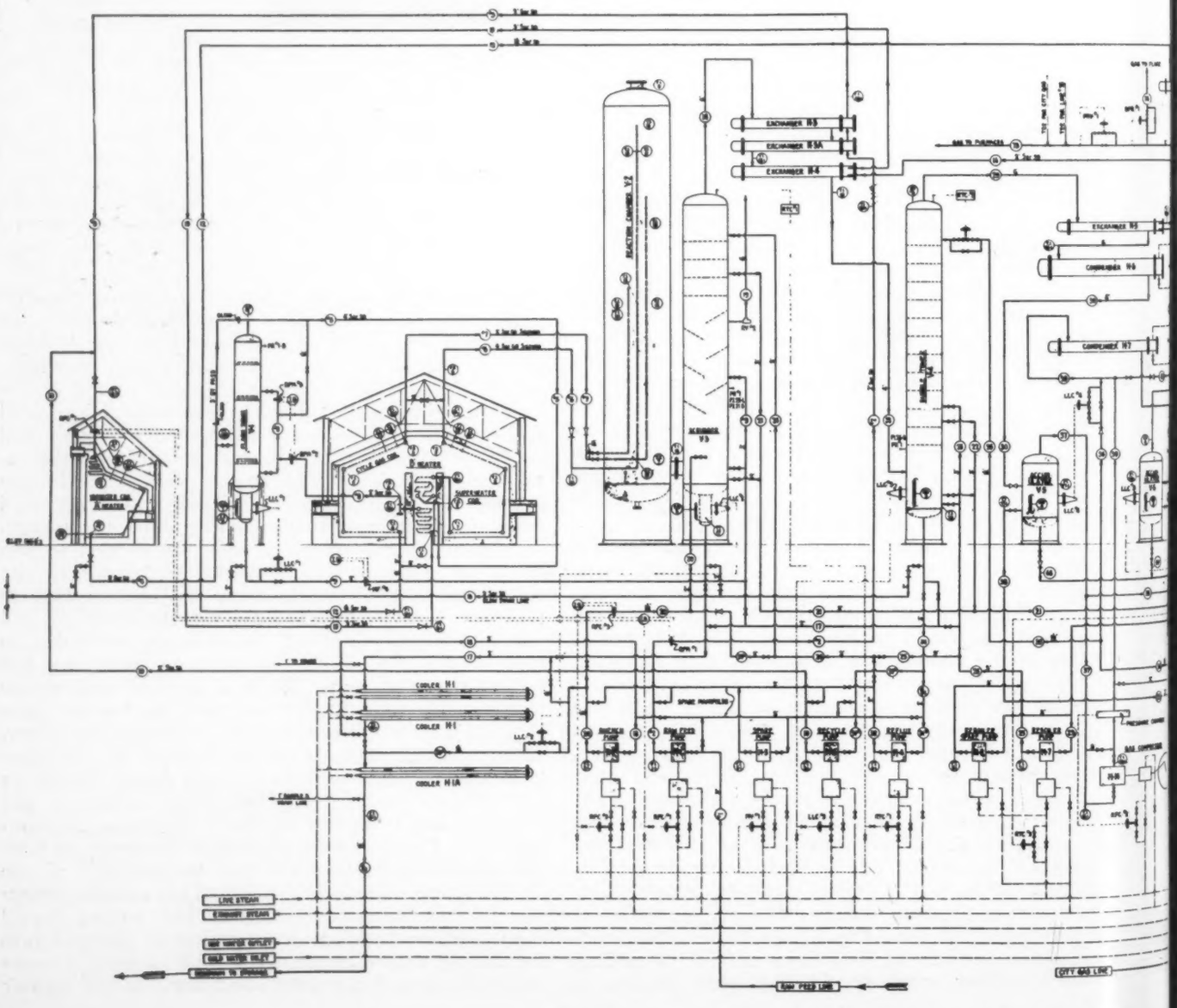
The accompanying paper was presented at the Twenty-sixth Annual Meeting of the Western Petroleum Refiners Association, Hot Springs, Arkansas, April 25-27, 1938.

CRACKING in the vapor phase has long been discussed in the industry. As a result there are certain general opinions existing that when applied to a specific process result in erroneous conclusions, as is usual when dealing in generalities. For example, the T. V. P. or True Vapor Phase process involves not only a means of changing various groups of hydrocarbons by subjecting them to heat-treating conditions, but provides a method of instantaneously and internally heating the hydrocarbons through the critical cracking range so that the usual loss and trouble encountered in that range is eliminated. This last heating is effected by mixing the superheated oil vapors with a high-temperature heat-carrier medium or as called in the operator's language, the hot-cycle gas. In addition through the use of the cycle gas the concentrations of certain hydrocarbons in the reaction zone are so controlled that the formation of excessive residual gas is suppressed, resulting in a maximum of high-octane gasoline. This method of heating and reaction control is a far cry from just heating the oil vapors to a high temperature and letting "the chips fall where they may." The effect of concentrations on various reactions is an extensive study in itself and its further development here is not properly within the scope of this paper.

The method of obtaining this T.V.P. operation is shown on the flow sheet, Figure 1. The stock to be cracked is charged into the unit through heat exchange and mixed with the recycle stock from the bottom of the fractionating tower. This mixture is heated in the vaporizer coil to such a temperature that when discharged into the flash drum in the presence of hot gas in the order of 900°F. and the approximate weight ratio of 1 pound of gas to 8 pounds of oil, there will be 85 to 100 percent vaporization, depending on type of cracking stock. Part of this hot gas is introduced at the top of the flash chamber to insure a completely dry vapor-gas mixture entering the superheater coil. In this coil the mixture of vapor and gas is heated very rapidly to within 20-30°F. of the desired reaction temperature. The outlet of the superheater coil joins the outlet of the hot-cycle gas coil, the stream from which will have a temperature of 1200°F. to 1275°F. according to the cracking condition desired. This mixture is then passed through an internally-insulated chamber where the desired reaction is completed. At the point of mixture there is approximately 1 pound original gas and 3.5 pounds original oil vapor. Discharging direct from the reaction chamber to the scrubber, the mixture of hot gases and vapors is cooled and scrubbed successively by cooled residuum and cooled reboiler oil to the extent required by the intensity of cracking. The excess condensate in the bottom of the scrubber is final fuel and is removed from the system through cooling coils to storage. At the top of the scrubber there are several bubble trays to which is returned the remainder of the cooled reboiler oil while from the bottom tray is taken the hot reboiler oil for use at the stabilizer and naphtha tower. Constant temperature condition is held at the top of the scrubber by refluxing hot bubble tower bottoms. The gas, gasoline and recycle leaving the top of the scrubber as vapors pass through heat exchange and into fractionating tower. The excess condensate in the bottom of the fractionating tower is returned to the vaporizer coil as previously described. The overhead products, gas and gasoline, from the fractionating tower are condensed and cooled and separated in the heavy or low-pressure accumulator. The top temperature of the fractionating column is controlled by refluxing from the low-pressure accumulator. The excess liquid from the low-pressure accumulator is pumped into the high-pressure accumulator to produce a more favorable partial pressure condition for the lighter

gasoline particles at that point. The gas stream leaving the low-pressure accumulator divides, one stream of make gas going to the absorber and then out of the system to the plant gas fuel line, and the other goes to the compressor which discharges it at inlet plant pressure, through coolers to the light or high-pressure accumulator where the light gasoline separates from the gas, combining with the gasoline from the heavy accumulator. This gasoline mixture is then taken through heat exchange to the stabilizer where it is reduced in vapor pressure to some point less than the final requirement. Part of this stabilized gasoline is taken to the naphtha tower where it is fractionated into two parts, the bottoms being pentane-free. The tops of this naphtha tower are then condensed, cooled and taken out of the system to gasoline storage, combined with the remainder of the stabilized gasoline not taken to the naphtha tower. The pentane-free bottoms are cooled and used as absorbing medium against the make gas. This enriched absorption medium is returned to the stabilizer to complete its cycle. The stabilizer tops are passed through heat exchange and into the cycle-gas coil after which they mix with the superheated oil vapors. The gas from the high-pressure accumulator passes through heat exchange and divides, part going to flash and drying gas heating coil which discharges into the flash drum and the other part goes to the cycle-gas coil with the stabilizer tops to form the high-temperature carrier medium. There are no excess stabilizer tops to be taken out of the system, as they are held in any desired balance by either changing the amount of high-pressure-accumulator gas to the cycle-gas coil or by changing the outlet temperature of the cycle-gas coil.

The flow layout just described is one of general utility. It is applicable for all degrees of cracking or reforming. If the unit were to be used for one specialized duty there are certain portions that could be omitted. However, due to the flexibility of this type of operation the savings in original cost effected by specializing are seldom large enough to justify limiting the operation of the unit to one charging stock. On the other hand, there is additional equipment that could be added for the handling of very heavy, viscous stocks. Also this extra equipment may



be added for additional control of the distillation characteristics of the cracked gasoline.

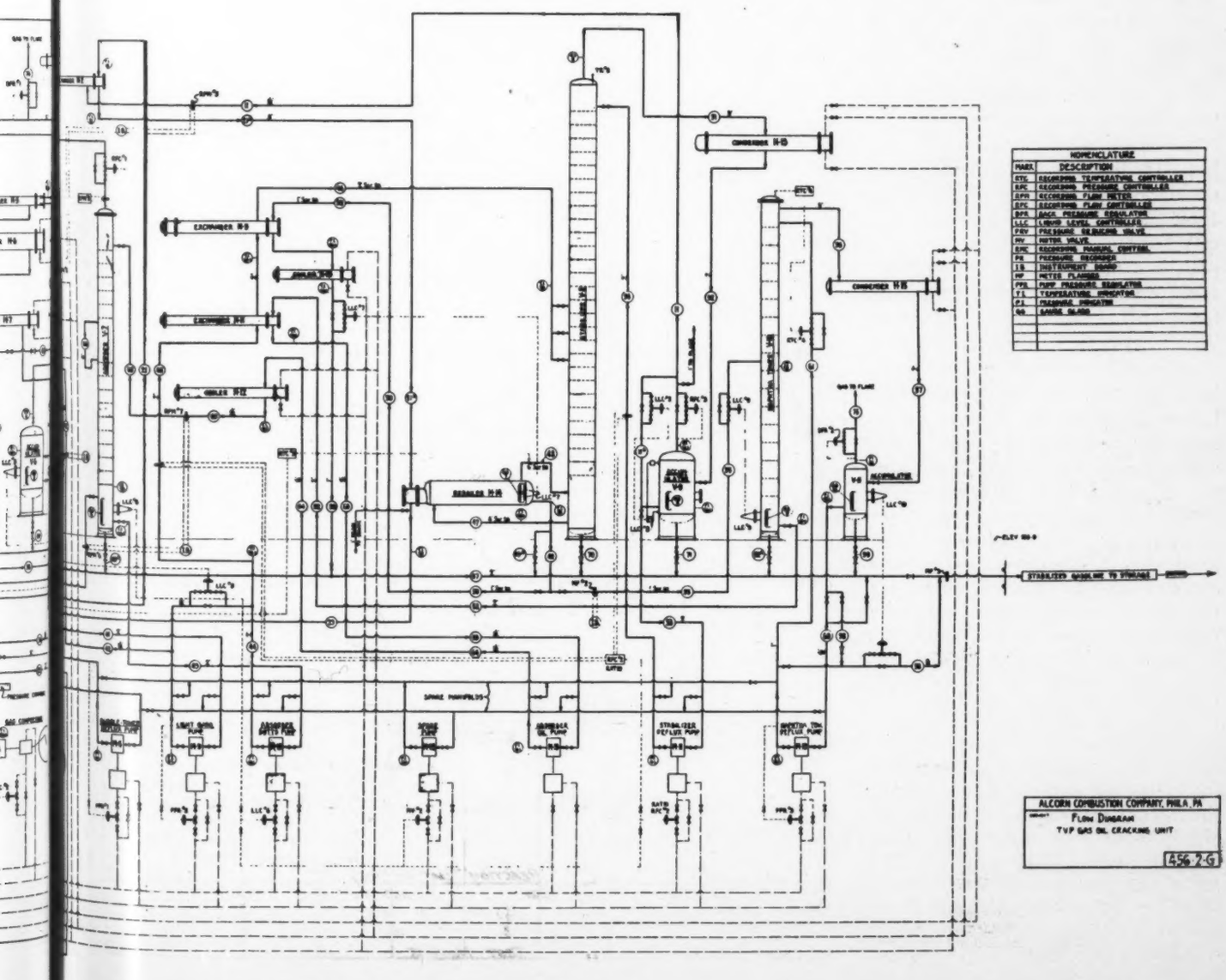
The flexibility of the unit is demonstrated not only by its efficient use for all types of stocks but also by the wide range over which any given stock can be cracked. This applies not only to octane value but also to end point of cracked gasoline. If the end point is either raised or lowered the effect can be immediately balanced in the cracking zone by the changing of one of the various controllable cracking factors. The raising or lowering of the octane is effected with the same simplicity and ease.

An indication of this wide range of operation was demonstrated on a T.V.P. unit while charging a gas oil from a noted paraffin-base crude. Holding the end point constant at 410°F. the octane of the cracked gasoline was worked from as low as 67 to as high as 78 by merely changing the mix temperature, which as explained previously, is the temperature resulting from combining of the superheated vapor and hot-cycle gas streams. This temperature is in itself controllable in three ways. First, varying the outlet temperature of hot-cycle gas coil, second, varying quantity through the hot-cycle gas coil, third, varying the outlet temperature of the superheater coil.

Although the unit was operated for a reasonable length of time at the extreme ranges of the cracking limits just mentioned there were no indications of coke deposit or other difficulty which might cause a shut down. This absence of coking in the heating and reaction zone can be attributed to the fact that the final heating of the oil is in the vapor phase and is accomplished by heat transfer from intermingling hot gases while also in the high-temperature zone there is present a large ratio of gas to oil.

The only tendency to form coke in the unit occurs during the first cooling stage or scrubber. Applying the principle of scrubbing, (that is, complete intimate contact), and keeping a positive flow of liquid over any trays in this chamber eliminates completely any coking effect. The only chance for coking in the heating tubes lies in careless operation, and it has to be excessively careless because it requires a considerable quantity of liquid in the vapor- or gas-heating coils to cause possible trouble.

Although the T.V.P. unit can be represented



graphically as three cycles based on different centers with varying degrees of overlap, the manner in which it is set up mechanically makes it an easy unit to start up, bring to equilibrium and hold to uniform operation. The flow and distribution of all gases in the system is automatically controlled by flow controllers and various types of pressure regulators. This also automatically controls the pressure on the system. The circulation of liquid is automatically governed by flow, liquid-level or combination control. The primary heat input as reperesented by the various coil outlet temperatures can be automatically controlled but it is found to be perfectly satisfactory to control manually with the various temperatures recorded.

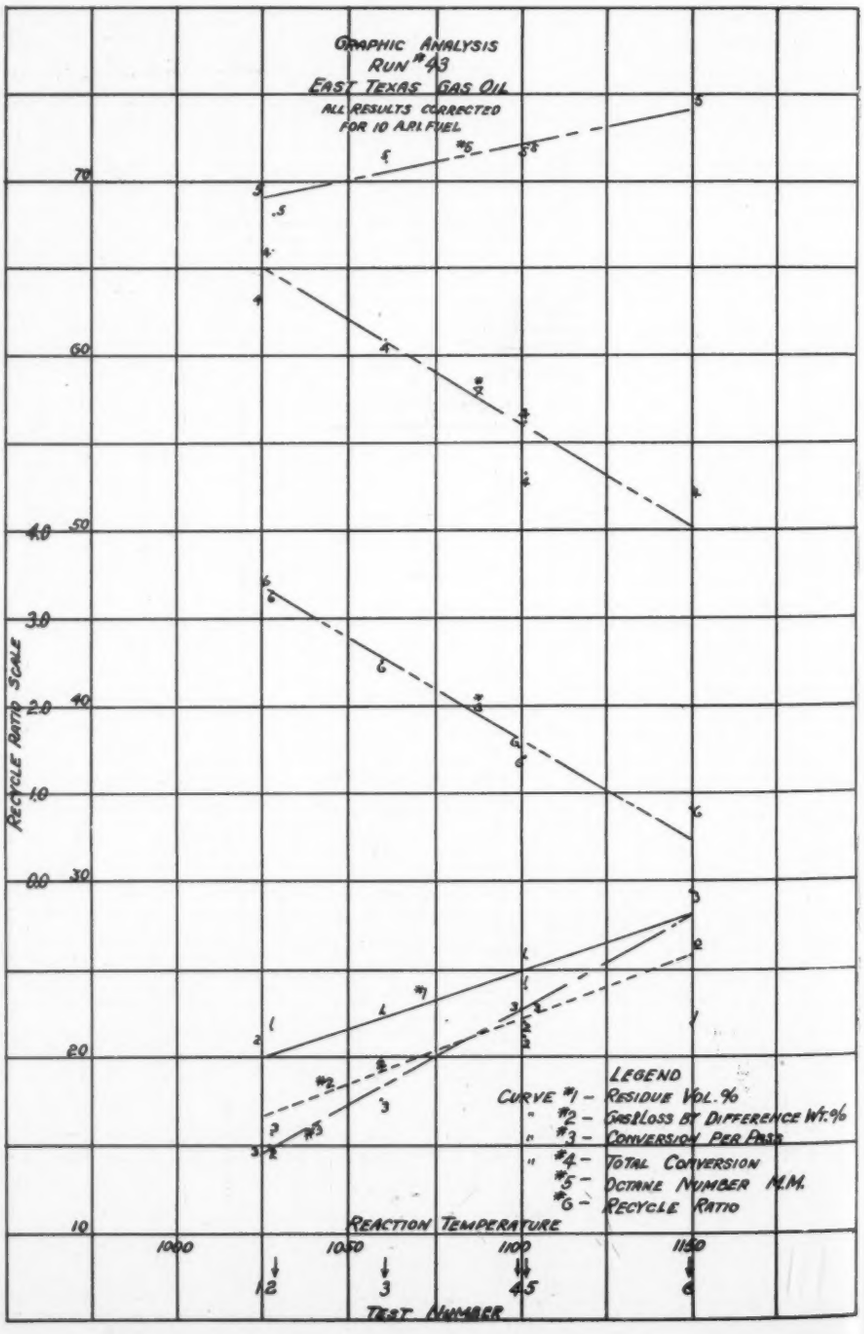
There is one characteristic of this process that is valuable from the operators' angle but it is difficult to find the proper word for its description. Probably the best word to use would be "resilience." A T.V.A. unit seems to recuperate from trouble with ease and with no scars or anything to interfere with its continuing operation. Utility failures of all kinds have occurred during operation, automatic control has gone out of service and not been caught promptly, and the only result has been a short interval of rough operation easily smoothed out and with no after effects.

The cracking temperature or mix temperature will vary not only for the intensity of reaction desired but also for quality of the stock processed. The range of 960°F. to 1100°F. will cover the possible requirements apparent today. The pressure at which these temperatures would be effected would vary from 110 to 135 pounds per square inch gauge, according to pressure-drop requirements. Because of the large amount of gas present the temperature at the bottom of the scrubber and also the fractionator are of course relatively low being 675°F. and 500°F. respectively.

The attached chart is offered not as a measure of ability of a T.V.P. unit, but to demonstrate its operating characteristics. Here are plotted octane gasoline yield, gasoline crack per pass, fuel oil yield, gas and loss by difference weight percent, and recycle ratio, all against reaction or mix temperature. Although this chart covers a wide range of conditions it only represents what can be accomplished by changing one variable, that is the mix temperature. Also it only shows operation when producing gasoline with octanes above that generally produced in the industry from the particular charging stock. Hence this chart is not a comparison but a picture of a new field.

The pictures of T.V.P. plants presented mean but little sitting here. However, after having listened to the story of the gas circulating through the various vessels, in and out of contact with the oil vapors, it may add a sense of reality. As a matter of fact, the only apparent mechanical difference noticeable when inspecting these plants is that there is a gas compressor instead of the hot-oil pump to which the industry has been accustomed.

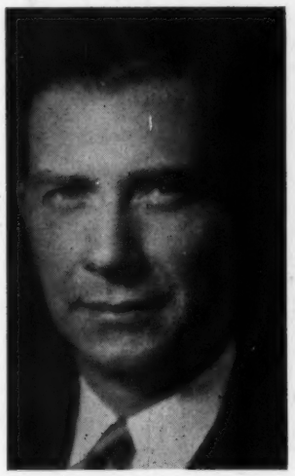
It has not been the object of this paper to offer data showing tantalizing results but only to explain "what makes the wheels go 'round." For those refiners with a cracking problem on their hands today the Alcorn Combustion Company is prepared to offer a solution through a T.V.P. unit based on complete tests of the particular stock at the pilot plant of the Petroleum Conversion Corporation just completed at Elizabeth, New Jersey.



Economic Aspects of the Pawhuska Road Tests

W. W. SCHEUMANN

Cities Service Oil Company



Mr. Scheumann, a graduate of Purdue University, has been chief chemist of Cities Service Oil Company since 1926. In 1923 and 1924 he was research chemist for Aluminum Company of America. He entered the oil industry in 1924 in the chemical department of Cities Service Refining Company in Western Petroleum Refiners Association - Natural Gasoline Association of America, Boston, Mass. He was a member of the steering committee which conducted the road tests in the summer of 1937 which disclosed the octane and vapor losses caused by inefficient fuel and carburetion systems on many motor cars.

This paper was read and occasioned much discussion at the Western Petroleum Refiners Association's Twenty-sixth Annual Meeting at Hot Springs, Arkansas, April 25-27, 1938.

THE choice of petroleum fractions which can be successfully included in motor fuels is governed by numerous factors. One of the most important of these is the operating characteristics of the motor vehicle fuel systems. Information concerning the behavior of automobile fuel systems in service is rather meager, and in order to study this factor, there was sponsored jointly by the Western Petroleum Refiners Association, and the Natural Gasoline Association of America, during the summer of 1937, an investigation of the performance of fuel systems of representative 1937 model automobiles. Tests were made, over a period of three months, on nine 1937 model cars which were driven approximately 10,000 miles over a selected course, in the vicinity of Pawhuska, Oklahoma.

The tests were made by a full time group of investigators, headed by Mr. R. R. Couch, under the direction of a steering committee composed of representatives from the two above named organizations. As defined by this committee, the project was carried out with a threefold purpose in view, namely, (1) to make a critical study of existing road-test procedures in order to determine their limitations; (2) to improve upon existing methods and develop better road-test procedures for the measurement of permissible vapor pressures, volumetric losses, and quality deteriorations of fuel; and (3) to obtain as complete information as possible on the fuel system characteristics of representative 1937 model automobiles.

The test procedures employed in this work for the measurement of permissible vapor pressures, vapor loss, and octane number loss, have been described in detail by Legatski and Couch[1] in a paper on this work presented before the Eighteenth Annual Meeting of the American Petroleum Institute. For this reason only a brief mention of them will be made in this discussion. Vapor lock tests were made in accordance with the A. P. I. tentative 1937 road-test procedure at 55 miles per hour. This consisted of determining by trial the highest vapor presssure gasoline which would permit a car to be started and accelerated to 55 miles per hour after a five-minute stop at the end of an extended period of driving at constant speed. Fuel samples were withdrawn from the tank for test after each observation. Three alternative types of fuel handling equipment were studied.

Vapor losses were determined by means of a calibrated density variation method, from measurements made on samples taken from the car tank and carburetor bowl over a 30-mile driving distance.

Octane number losses were related to vapor losses from data secured in the development of the density method for vapor losses.

The test results obtained in this investigation were also given in part by the previously mentioned writers. However, they will be repeated here, in part, to an extent sufficient for purposes of discussing (1) the economic meaning of these results to the refining industry, and (2) the economic meaning of these results to the motoring public.

IMPORTANCE OF THE PAWHUSKA ROAD TESTS TO THE REFINING INDUSTRY

a. Permissible Vapor Pressures.

In considering the data on maximum permissible vapor pressures, it should be kept in mind that these values are for extreme conditions, and that under normal driving conditions a somewhat higher vapor pressure fuel can be handled. In addition, these results are based on the fuel in the tank after vapor

lock has occurred, and, therefore, are not necessarily indicative of vapor pressures permitted for fuels at the service station, or the refinery. These results, however, do compare fuel systems in various makes of cars, and are indicative of the differences which exist in such systems.

The test results, using the standard reference fuels, are shown in Table 1.

TABLE 1
Maximum Permissable Reid Vapor Pressures

Car Designation	Atmospheric Temperature			Slope of V.P.—Temp. Curve
	80° F.	90° F.	100° F.	
A	12.23	10.62	9.04	0.158
B_1	11.38	10.15	8.96	0.119
B	11.42	9.10	6.82	0.228
C	12.00	10.12	8.92	0.120
D	.....	9.30	7.70	0.160
E	10.87	8.82	6.80	0.202
F	.....	9.27	7.93	0.134
G	11.47	9.90	8.35	0.155
H	.....	10.01	8.20	0.181

In order to discuss these results in terms of their significance to the refiner, consideration will be limited to a comparison of the car showing the highest permissible vapor pressure for a given temperature, which is car A, with the car showing the lowest permissible vapor pressure, which is car E.

A major premise of this discussion is the statement that the refinery must, and is building fuels for the poorest car from this standpoint. Therefore, if the poorest car were improved to equal the best the refiner could take advantage of the ability of such cars to handle higher vapor pressure fuels, and could include a corresponding increased amount of butane in his product.

Table 2 indicates the difference in butane content of the maximum vapor pressure fuels which can be handled by cars A and E, at various atmospheric temperatures.

TABLE 2
Butane Content Related to Vapor Pressure of Fuel

Atmospheric Temp.° F.	Maximim Vapor Pressure		Butane Content of Fuel-Percent		Difference in Butane Content Percent
	Car A	Car E	Car A	Car E	
Below 60	....	....	no difference		....
60	15.39*	14.91*	11.20	10.60	0.60
70	13.81*	12.89*	9.30	8.20	1.10
80	12.23	10.87	7.40	3.80	1.60
90	10.62	8.82	5.48	3.33	2.15
100	9.04	6.80	3.60	0.95	2.65
110	8.46*	4.78*	2.90	....	2.90

* Extrapolated value.

In order to convert the differences in possible butane contents into motor fuel volumes, it is necessary to estimate the ratio of fuel requirements at various atmospheric temperatures. Such a break up of motor fuel requirements has been calculated, based on daily average maximum temperatures over a year's period by states, as shown in the Atlas of American Agriculture[2], and the gasoline volumes sold in various states by months, as shown in the A. P. I. statistical bulletins.

Using this basis of calculation, Table 3 shows the volumes of butane which could be included in motor fuels, if instead of building them for a car as poor as Car E with respect to permissible vapor pressures, they could be built for a car as good as Car A. This table is calculated on a basis of 525,000,000 barrels total annual motor fuel requirement.

TABLE 3
Estimated Conversion of Butane to Motor Fuel

Average Daily Maximum Temp. ° F.	Percent Annual Fuel Requirement	Possible Increased Butane Utilization	
		Percent	Barrels
Below 60	20.19	none	none
60	14.68	0.60	462,420
70	15.53	1.10	896,855
80	23.31	1.60	1,958,040
90	20.66	2.15	2,331,998
100	5.25	2.65	730,406
110	0.38	2.90	57,855
Total	.....	.....	6,437,574

This amounts to an average of 1.226 percent additional butane in motor fuel.

The value of this increased utilization of butane to the refiner may be calculated in various manners. In a study of butane availability made by Alden[3], it is stated that there are approximately 62,500,000 barrels of butane per year, which are available for but unused in motor fuel. (This does not include the butane content of unprocessed natural gas.) Therefore the increased amount of butane which could be used as motor fuel is probably now only valued at the price of fuel gas. If we take this to be 10 cents per 1,000 cubic feet and the refinery price of gasoline as 5½ cents per gallon, then the increased value of this butane as motor fuel nets to the refiner $16,400,000.00 annually.

If calculated on a crude oil basis, assuming a 50 percent gasoline yield from crude, the increased use of 6,400,000 barrels of butane as motor fuel reduces crude requirements 12,800,000 barrels which at $1.15 per barrels shows approximately the same net saving to the refining industry.

A second factor which merits consideration is the effect of this additional butane on lead requirements in the finished motor fuel. The average blending value of butanes is from 90 to 92 octane number. Considering 70 percent of the motor fuel ethylized with an average lead content of 0.65 cc. per gallon, it may be calculated that the use of this additional butane would result in a savings for ethylizing expense for the same octane number product, of $1,862,000.00 annually.

Therefore, from solely the standpoint of permissible vapor pressures, the petroleum industry would realize potentially in the neighborhood of $18,000,000.00 annually if the fuel system of the poorest car were improved to the point of equalling the best.

b. Fuel Losses.

It has been common knowledge for some time that a portion of the fuel is lost from the automobile fuel tank through the vaporization of light ends from the tank itself. In recent years, however, a second source of fuel loss has also become increasingly important, although it has received little mention. This is the fuel loss from the carburetor. In an attempt to minimize vapor lock, some car builders have worked toward lower fuel line temperatures by means of location, insulation, or other methods. Other manufacturers, however, have stressed increased vapor handling capacity of the fuel system and the venting of carburetors, so that the fuel system can handle considerable amounts of vapor which is vented to the atmosphere when it reaches the carburetor. This loss of fuel from the rear tank and the carburetor was also investigated as a part of the Pawhuska tests, in order to obtain information

regarding the volumes of such losses and the effect of these losses on the degradation of fuel quality.

Exhaustive measurements were only made on two cars. On these cars losses were measured on the car tank and carburetor bowl liquid, over a range of atmospheric temperatures, using standard reference fuels over a range of vapor pressures. It was found that a fairly close relationship existed between the vapor pressure of the fuel in the car tank, the carburetor bowl temperature, and the observed volumetric loss of fuel. This enabled probable vapor losses to be calculated for all the cars on which temperature measurements had been made. The results of such calculations are shown in Table 4.

TABLE 4
Probable Vapor Losses for Conditions of Steady Driving at 55 Miles per Hour—Volume Percent

CAR	Atmospheric Temp. ° F.	8.0 Lb. Vapor Pressure Fuel			9.0 Lb. Vapor Pressure Fuel		
		Carburetor Bowl	Rear Tank	Total	Carburetor Bowl	Rear Tank	Total
A.....	90	1.02	1.40	2.42	1.52	1.66	3.18
	100	1.67	1.89	3.56	2.17	2.25	4.42
B.....	90	0.93	....	....	1.43	....	....
	100	1.55	....	....	2.05	....	....
C.....	90	0.65	....	....	1.15	....	....
	100	1.20	....	....	1.70	....	....
D.....	90	1.57	....	....	2.07	....	....
	100	2.20	....	....	2.68	....	....
E.....	90	1.00	1.30	2.30	1.55	2.30	3.85
	100	1.40	3.30	4.70	1.90	4.20	6.10
F.....	90	1.72	1.00	2.72	2.22	2.00	4.22
	100	2.33	2.70	5.03	2.80	3.70	6.50
G.....	90	1.40	1.50	2.90	1.90	1.85	3.75
	100	1.95	2.09	4.04	2.45	2.55	5.00

In relation to these data it should be remembered that these are minimum losses experienced under conditions of steady driving. A limited number of observations made under conditions of intermittent driving and stopping, indicate sustantially higher losses.

While the major economic effect of these losses relates directly to the cost of motor fuel to the consumer, they are also of interest to the refiner in that they illustrate the extent to which the fuel he has so carefully prepared and distributed is degraded, after it has been delivered to the final consumer. The average motorist has no conception of the fact that such degrading of the fuel occurs in his car, and any complaints regarding quality are immediately laid at the door-step of the refiner. This is particularly true of anti-knock complaints.

The fuel losses observed relate directly to loss of octane number. Investigation of this relationship indicated that a loss of from 0.25 to 0.3 octane numbers occurred for each 1 percent loss of fuel. Since a large proportion of present day cars under usual operating conditions are on the threshold of undesirable detonation with 72 octane L-3 gasoline, particularly in hot weather, it may readily be seen that a volumetric loss of from 4 to 7 percent, which would result in an octane number loss of from 1.1 to 2.0 octane numbers could easily mean the difference between satisfactory and unsatisfactory performance of the fuel.

In a later portion of this paper, the annual average overall fuel loss from this source is estimated conservatively at 1.96 percent. This would mean an average equivalent loss of 0.54 octane numbers. If we relate this octane number loss to an equivalent amount of Ethyl fluid on 70 percent of the annual motor fuel requirement, it appears that the refiner spends over $2,000,000.00 annually for anti-knock value, which is lost after the fuel is put into the rear tank of the automobile and before it gets into the engine.

These fuel losses therefore are of considerable importance to the refiner since they tend to prevent his customer from obtaining the performance from his product which, at a considerable cost to him, was built into it.

THE MEANING OF THE PAWHUSKA ROAD TESTS TO THE MOTORING PUBLIC

a. Permissible Vapor Pressures.

At a first glance, it would appear that improvement in higher permissible vapor pressures for motor fuels would work chiefly in economic benefit for the refiner. However, a review of past history clearly indicates that the petroleum industry has always passed on to the consumer in large proportion the benefits of more economical production of its products. This would undoubtedly also be true in this case. Moreover, the conservation of crude oil, which would be made possible through better utilization of butane, is certainly in the interest of the public.

Therefore the benefits which would result from better fuel systems from the angle of permissible vapor pressures are not only significant to the refiner, but are also of considerable interest to the motor fuel consumer.

b. Fuel Losses.

The fuel losses from the rear tank and from the carburetor come directly out of the consumers pocket. To him such losses mean less miles per gallon, or conversely a proportionately greater fuel cost per mile.

Any attempt to make an accurate estimate of what the monetary value of these losses mean to the consumer is almost hopeless due to the many unknown factors involved. However, it is believed that, with a very few assumptions, a minimum estimate can be made which represents the minimum value these losses attain.

Over an atmospheric temperature range of from 80°F to 110°F this loss appears to be some figure over 4 percent. On an annual basis, this minimum figure is reduced, since 12.0 pounds gasoline is about the maximum vapor pressure of fuels, even when used at very low temperatures. In order to estimate what this minimum figure might be on an annual basis, it is necessary to estimate a relationship between the fuel volumes and the temperature at which they are used. Fuel vapor pressure specifications are usually based on average maximum temperatures,

TABLE 5
Relationship of Fuel Consumption and Atmospheric Temperatures

Atmospheric Temp. ° F.	Estimated Percent Fuel Consumption		
	Based on Average Temp.	Based on Average Maximum Temp.	Mean
Below 70.....	55.93	34.87	45.40
70.....	22.70	15.53	19.12
80.....	17.44	23.31	20.37
90.....	3.90	20.66	12.28
100.....	0.03	5.25	2.64
110.....	....	0.38	0.19

but the fuel is used at some lower average temperature, and it is believed that the mean of the average daily maximum and the daily average is a fair figure for this purpose.

Such an estimated relationship of fuel consumption, and temperatures, is shown in Table 5.

The vapor pressures of motor fuels sold for use at various average maximum atmospheric temperatures vary from 8.0 to 12.0 pounds. Motor fuel surveys indicate the relationship shown in Table 6.

TABLE 6

Fuel Vapor Pressure vs. Average Maximum Atmospheric Temperature

Average Maximum Temperature ° F.	Vapor Pressure at 100° F., Lbs.
110	8.0
100	8.0
90	9.0
80	10.0
70	12.0
Below 70	12.0

In order to use these figures, the data on four cars, taken from Table 4, and from detailed studies made on two of them, have been extrapolated, and related to the vapor pressure of fuels used, as shown in Table 7.

TABLE 7

Extrapolated Fuel Losses at Various Temperatures and Fuel Vapor Pressures—Percent

CAR	Fuel Vapor Press.	Average Maximum Atmospheric Temperature—° F. 70	80	90	100	110
A	8.0	....	....	....	3.6	4.7
	9.0	....	....	3.2	....	....
	10.0	....	2.8	....	....	....
	12.0	2.5	....	....	....	....
E	8.0	....	....	....	4.7	7.1
	9.0	....	....	3.9	....	....
	10.0	....	3.3	....	....	....
	12.0	4.6	....	....	....	....
F	8.0	....	....	....	5.0	7.4
	9.0	....	....	4.2	....	....
	10.0	....	3.4	....	....	....
	12.0	4.8	....	....	....	....
G	8.0	....	....	....	4.0	5.2
	9.0	....	....	3.8	....	....
	10.0	....	3.5	....	....	....
	12.0	3.2	....	....	....	....
Average	.....	3.78	3.25	3.78	4.33	6.1

Combining the temperature and fuel consumption figures from Table 5, the vapor pressures from Table 6, and the average losses from Table 7, an estimate of the annual fuel loss is made in Table 8.

A conservative estimate of minimum annual fuel losses from rear tanks and carburetors of cars is

TABLE 8

Estimated Average Annual Fuel Loss

Meam Atmospheric Temperature ° F.	Average Overall Loss	Percent Annual Fuel Requirement	Annual Fuel Loss Percent
Below 70	....	45.40	....
70	3.78	19.12	0.72
80	3.25	20.37	0.66
90	3.78	12.28	0.46
100	4.33	2.64	0 11
110	6.10	0.19	0.01
Total	.....	.....	1.96

therefore placed at 1.96 percent. On the basis of an annual motor fuel consumption of 525,000,000 barrels at an average filling station price of 15 cents per gallon, the motoring public pays at least $65,000,000.00 per year for fuel which is lost from the automobile. The actual figure probably runs considerably in excess of this amount.

CONCLUSIONS

Ignoring the technical features, relating to road test technique developed by this work, and confining the conclusions reached only to the economic aspects, it may be stated:

a. The fuel system characteristics of the nine 1937 model cars tested vary considerably.

b. From the standpoint of permissible vapor pressures, if the poorest car were improved to equal the best, the refining industry could utilize additional butane in motor fuel, amounting to 1.226 percent of the annual motor fuel requirements. It is estimated this would net the industry at lease $16,000,000.00 annually, and, in addition, decrease lead expense by $1,800,000.00.

c. Fuel losses from rear tanks and carburetor vents will run from 4 to 7 percent in hot weather, and higher, depending upon the type of driving. A conservative annual estimate of 1.96 percent minimum loss has been made by the writer.

In hot weather this accounts for octane number losses of 1.1 to 2.0 octane numbers, and will average at least 0.54 octane numbers on an annual basis. In terms of lead, this anti-knock loss is valued at approximately $2,000,000.00.

An annual fuel loss of 1.96 percent from the car costs the consumer at least $65,000,000.00.

REFERENCES CITED

[1]Legatski, T. W. and Couch, R. R. Fuel Systems of 1937 Automobiles Proceedings 18th Annual Meeting American Petroleum Institute, Chicago, Illinois, November 8 to 12, 1937. See Refiner, November, 1937, page 527.

[2]Kincer, Joseph B. Atlas of American Agriculture, Part II Climate, "Temperature, Sunshine and Wind."

[3]Alden, R. C. Butane, A Wasted Asset of the Petroleum Industry. Refiner and Natl. Gasoline Manftr. 13, (6), 208-14, (1934) June.

The Fuel System Characteristics *of Vapor Locking Automobiles*

T. W. LEGATSKI

Phillips Petroleum Company, Committee Chairman

A JOINT investigation of the characteristics of representative 1937 car fuel systems was conducted by the Natural Gasoline Association of America and the Western Petroleum Refiners Association. During the course of this work, 251 tests were made on eight 1937 model cars and one 1936 model. The tests involved some 10,000 miles of driving and required about three months to complete. Aside from the development of a number of new or modified testing procedures, the information obtained was deemed sufficient to warrant the following general conclusions with respect to current models of cars:

1. The permissible rear tank fuel vapor pressure for trouble-free operation under the worst conditions at an atmospheric temperature of 100° F. is about nine pounds for the three popular priced 1937 cars. All but two of the remaining cars indicated permissible vapor pressures close to eight pounds, the two exceptions showing permissible vapor pressure values near seven pounds. The vapor pressure values are those for normal summer gasoline, since with more extreme fuels some of the values were lower.

2. The average temperature rises through the fuel systems of 1937 cars do not appear materially different from those reported for earlier models.

3. The overall losses from representative fuel systems, when using the gasoline normally sold for the atmospheric temperatures then prevailing, will range from approximately four percent to some higher value, depending upon the "trouble-free vapor pressure requirement" of the car in question and upon the type of driving. Starting with an overall loss of approximately four percent as average for cars with trouble-free vapor pressure requirements of eight to nine pounds, the probable loss appears to increase at the rate of one percent additional for each drop of one pound in the "trouble-free vapor pressure requirement." These losses are minimum losses, i. e., losses for trip driving with no stops between successive fillings of the tank. Loses to be expected for the condition of about-town driving with its repeated starts and stops are substantially greater, a limited number of observations indicating that they would be of the order of two and one half times those observed for trip driving.

4. The corresponding overall loss in octane number suffered through fuel evaporation will be appreciable. A drop of 0.25 to 0.3 A.S.T.M. octane number for percent loss through evaporation appears to be the least that could be expected from these tests. This means that the A.S.T.M. octane number drop suffered on average summer gasoline in cars having vapor pressure requirements of eight to nine pounds will be approximately one octane number while losses of two octane numbers could conceivably be expected in the case of cars of extremely low "trouble-free vapor pressure requirements."

This paper is the report of the N.G.A.A. and W.P.R.A. Road Test Steering Committees, and was presented before the annual meeting of the Natural Gasoline Association of America, Tulsa, May 11-13.

THE interest of the petroleum industry in car fuel-system designs is, as you know, prompted by the observation that inadequate fuel systems impose serious restrictions on gaoline raw materials. The nature of these restrictions and the volumes of potential gasoline raw materials involved have been covered in a number of papers and the results of such studies need not be reviewd here. However distressing the matter of excluding from consideration large volumes of potential gasoline raw materials may be, inadequate fuel systems also result in operating difficulties such as vapor lock, in lost mileage through losses of vaporized gasoline at various points in the system, and in quality losses such as decreased anti-knock value, decreased ease of starting, etc. These other undesirable characteristics of poor fuel systems have been appreciated for some time in a qualitative fashion. To our knowledge, however, very little if any quantitative information has been made available to fuel system designers on these various items.

Because the fuel systems of the various makes and models of cars continue to be far from equal in their ability to handle fuels without operating troubles and without excessive losses, fuel manufacturers are continuing to observe fuel specifications which will result in substantially trouble-free operation in the poorest systems. Apart from the restrictions which such a situation imposes on fuel manufacturers, the cars which could handle a better fuel are, of course, definitely penalized. In substance, all studies to date have indicated that better fuel systems would benefit the car designers, the fuel manufacturers, and the car owners. Besides making better use of our present-day gasoline, better systems would doubtless aid in paving the way toward better and cheaper fuels. This is such an important consideration that it cannot be ignored. The continued trend toward more volatile, more highly unsaturated fuels, with potentially higher vapor pressures, means that we must continue to focus our attention on fuel systems, their various characteristics and particularly their limitations.

Lack of progress toward better fuel systems has been attributed in some quarters to the lack of accurate information on some of the effects traceable to poor designs, with no methods available for obtaining such information. It is true that the two interested industries employ a number of road testing procedures. The test results obtained in the course of applying such procedures have, however, been frequently questioned as to just what they mean. Here are a few samples of the questions that are frequently asked: Do such methods

actually rate cars, or do they merely tell us whether the fuel in question would or would not give trouble-free operation? What have these methods taught us in regard to normal minimum mileage losses traceable to poorly-designed systems? Furthermore, with these methods, what have we learned in regard to the fuel quality losses incurred when the fuel passes through such systems to the intake manifold of the engine? We need not answer these questions because you already know the answers. Clearly, questions of test adequacy, true rating of fuel systems, nature and magnitude of volumetric and quality losses, etc., are all questions which merit answers—more complete answers than we now have.

These general remarks by way of introduction bring us to the purpose of the Pawhuska Road tests, tests which were jointly conducted by the Natural Gasoline Association of America and the Western Petroleum Refiner's Association during the summer of 1937. As outlined by the steering committee in charge of this work, the purpose was a threefold one, namely; (1) to study the existing road-test procedures critically to determine their limitations; (2) to work toward the development of more satisfactory road-test procedures for the determination of permissible vapor pressures, volumetric losses, and quality losses; and (3) to obtain as much and as complete information as possible on the fuel system characteristics of a number of representative 1937 cars. This turned out to be a more ambitious program than was anticipated by the steering committee. For this reason, the results and the conclusions of the work which will presently be submitted should be viewed and considered as one would any piece of exploratory work. Although the results obtained are interesting, and as we believe, highly significant, they should mainly serve to illustrate the need for more exhaustive studies of this general type. The present paper is a summary paper based upon the more complete report which was submitted at the conclusion of the road test program.

TEST PROCEDURES

The test methods and the apparatus employed to obtain information on the permissible vapor pressure of fuels for trouble-free operation at various atmospheric temperatures, on the temperatures prevailing at various points in the fuel system as a function of atmospheric temperature, on volumetric losses from fuel systems through evaporation, and on the resultant fuel quality losses, will be briefly described in the following paragraphs.

Permissible-Vapor-Pressure Test Procedure

The permissible vapor-pressure test procedure involved the use of one test method with three alternative types of fuel handling equipment. In technical circles, the method is known and referred to as the 1937 tentative standard vapor-lock road-test method. In brief, this method calls for test runs on the car at various atmospheric temperatures, preferably above 85°F., using fuels of closely-specified distillation characteristics and of different vapor pressures. For convenience, the fuel used is designated as the standard vapor-lock reference fuel. Its value as a yardstick for classifying fuel systems resides in the fact that this fuel is a reasonably close approximation of average summer gasoline. The "vapor-locking vapor pressure" is considered in this test as being the highest vapor-pressure fuel which will permit a car to be started and accelerated to 55 miles per hour after a 5-minute stop at the end of an extended period of driving at constant speed. Samples of gasoline are withdrawn from the car tank at the end of each observation of car behavior for the purpose of checking vapor pressures. It is quite obvious that the permissible vapor pressures thus determined will be those for one of the worst conditions of operation because, after getting under way, a car can normally handle a product of somewhat higher vapor pressure than indicated by this test with no apparent operating difficulties. Because the conditions observed in this test are identical with those encountered in normal about-town driving, this method is inherently the soundest one for arriving at permissible vapor pressures. The most serious shortcoming of the method as a routine test procedure is its extreme unwieldiness. This is due to its being a "cut and dry" method, necessitating many trial blends and many miles of driving for a complete set of data on any one car. Alternative methods for handling the fuels in this test have frequently been suggested as a step toward simplification. All such suggestions have been looked upon with disfavor; because in each instance, modifications in the conventional fuel system were required, and it was feared that these would invalidate the results. Notwithstanding these past objections, three alternative methods for handling fuels were used in the course of the Pawhuska tests for the purpose of comparing results with those obtained in the conventional method. Each of these alternative methods merits a brief description.

Alternative No. 1, designated in the report as the "rear-rack method," involved the use of a number of one-gallon fuel containers mounted in a rack on the rear bumper of the car. A three-way valve was inserted in the regular fuel line close to the car tank in a fashion so that fuel could be used either from the car tank or from the gallon containers mounted on the rack. Fuel from the car tank would be used during the warm-up period and from the one-gallon containers for the actual vapor-lock tests. In normal testing each container would be filled with a fuel of different vapor pressure, so that observations could be conveniently made on a range of products in any one test run. At the conclusion of each observation, a check vapor-pressure determination would be made on the remaining fuel in the container.

Alternative No. 2, designated in the report as the "float-chamber method," involved the use of three five-gallon containers manifolded together and mounted in the rear-seat space of the car. The feed line from these containers passed to a float chamber mounted on the rear bumper of the car on a level with the car tank. The float chamber, designed for the purpose of eliminating the effect of a static head of gasoline on the fuel system, was of one-quart capacity, and delivered directly into the car fuel system at the rear tank connection. In the course of testing, each of the three five-gallon containers would be filled with a fuel of different vapor pressure. Warm-up and vapor-lock runs would be made on each tank. At the conclusion of each observation, a check vapor-pressure determination would be made on a sample of gasoline drawn from the float chamber.

Aternative No. 3, designated in the report as the "proportioning-valve method," was identical with No. 2 except that two five-gallon fuel tanks mounted in the rear-seat space delivered through a manually-controlled proportioning valve, and from thence to the float chamber on the rear bumper. In the normal operation of this equipment, test fuels differing from each

other by 3 or 4 pounds in vapor pressure would be prepared and charged into the two five-gallon fuel tanks. The proportioning valve, so designed that it would mix fuels accurately in increments of five percent, would be set at a desired point and road-test observations made, culminating in the withdrawal of a check sample from the float chamber. By trying a number of settings in rapid order, the complete range of vapor pressure could be conveniently explored in a relatively short period.

The actual details of the testing procedure, methods of making observations, etc., were kept the same in each case in order to facilitate comparisons of these various alternative methods of handling test fuels.

In order to accumulate information on other possibly more suitable types of test fuels, duplicate runs were made in each case with a product considerably more volatile than the previously-designated standard reference fuel. This choice was prompted by the opinion that a considerably more volatile reference fuel might afford one means of differentiating between systems which owed their fuel-handling ability to low temperatures and those which owed their fuel-handling ability to excessive wasting of vapors. The volatility characteristics of both pairs of reference fuels are

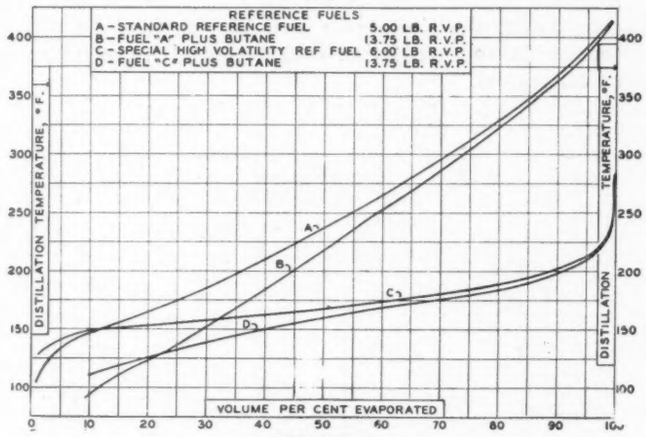


FIGURE 1

Distillation characteristics of test gasolines

shown in Figure 1. All of these fuels were prepared in quantities sufficient for the entire test program.

Fuel System Temperatures

As an integral part of the program of determining permissible vapor pressures, temperature observations were made at all important points in the fuel system. The equipment used for this purpose consisted of a potentiometer connected through a selector switch to thermocouples located fore and aft under the hood, in the crank case, in the rear tank, on both the inlet and discharge of the fuel pump and at the carburetor-bowl. To avoid changes in the fuel system, the thermocouples were soldered to the lines and to the carburetor-bowl. The connections thus made were then protected from damage by applying several turns of so-called friction tape. Temperatures were taken along toward the latter part of the stabilizing runs and also at the end of the five-minute stop period. Corresponding atmospheric temperatures were taken in each case with a mercurial thermometer.

Vapor-Loss Road-Test Procedure

In the absence of a generally accepted procedure for determining losses from fuel systems through evaporation, a number of methods were subjected to preliminary laboratory studies. Before describing the method which was ultimately adopted for our test program, a few remarks are in order on this subject of losses and their proper measurement.

The nature of losses, the factors influencing losses, and the means employed by fuel-system designers to avoid operating troubles, is bound to make the problem of loss measurement a difficult one. Obviously, any method which involves attachments to the fuel system, or which involves changes in the location, size, etc., of carburetor and rear-tank vents, will tend to affect losses, and will probably yield fictitious results. A sound method would be one requiring no changes whatsoever in the fuel system and no changes of any other sort which might affect the normal flow of air around the various elements of the fuel system. Losses will theoretically be affected by the physical properties of the fuel, by the temperature of the fuel at those points in the system where the fuel is free to evaporate, by any back pressure or sub-normal pressure which might restrict or increase evaporation at such points, and by the presence or absence of currents of air over the various points of venting in the system. With these things in mind, it appears probable that the test requirement could best be met by relying upon some sort of an over-all material balance of the fuel in the system. In other words, the difference between what goes into the rear tank and what ultimately arrives at the carburetor jet must be the loss. Such a loss procedure would require a closely-specified fuel plus provisions for drawing periodically representative samples from the car tank and the carburetor-bowl. Such was our scheme.

Sampling from the car tank presented no problem. The samples were withdrawn in the same manner as the vapor pressure samples. To obtain the necessary carburetor-bowl samples, a small hole was drilled and tapped in the base of the bowl close to and yet sufficiently far removed from the main jet to avoid robbing the jet. An insulated copper tube of small diameter, fitted with a stopcock and delivering into a chilled receiver, completed the assembly. In a series of constant speed driving experiments at normal road speeds, various rates of withdrawal of samples were studied. A rate was ultimately decided upon which was equivalent to between one and two percent of the normal car consumption at that speed. Rates as much as six times greater than the standard rate of withdrawal were found to have no noticeable effect on sample characteristics.

Consideration was next given to methods for arriving at a material balance on fuels. Analysis of the samples, although sound from a purely theoretical viewpoint, was considered objectionable because of insufficient accuracy and duplicability as well as being somewhat time consuming. Since the light fractions lost in normal evaporation processes have a definite and readily measurable effect on the specific gravity of the fuel, the conclusion was reached that a comparison of the specific gravities of the fuel in the car tank and the residual fuel in the carburetor-bowl had promise of yielding the desired information after such differences had been properly correlated with changes in fuel composition. Differences in specific gravity should reflect losses if the volatility characteristics of the fuel under consideration are closely specified.

An extended series of laboratory experiments on an improvised fuel system, involving loss determinations through the mechanisms of simple distillation and flash

vaporization, and supplemented by specific gravity determinations on all products as well as volumetric measurements of the condensed vapors liberated in the operation, supported this conclusion. The results were further substantiated by careful measurements on cars under test. In substance, the results indicate that each change of .001 in specific gravity was equivalent to a minimum loss of 1 percent. Expressed in terms more familiar to the layman, each change in A. P. I. gravity of 1 degree will be accompanied by a minimum loss of 3.5 percent by volume. This method is applicable to the measurement of losses of 10 percent or less, and always indicates the minimum loss for the observed specific gravity change because the loss is assumed to be through simple distillation. All that is required is a calibration curve of loss versus change in specific gravity for the fuel in question.

The normal procedure for making vapor-loss measurements consisted of sampling the contents of the car tank after the car had been thoroughly warmed up. A 90 cc. sample of residual carburetor-bowl liquid was then continuously drawn while driving a distance of 30 miles at average speed. At the conclusion of the run a second sample was taken of the fuel in the car tank. The difference between the specific gravities of the initial and final samples from the car tank was taken as the index of tank losses. The difference between the *average* specific gravity of the fuel in the car tank during the test period and that of the carburetor-bowl sample was taken as the index of bowl losses. All specific gravities were determined on a West-phal balance. A calibration curve of minimum loss versus specific gravity change made the matter of conversion to terms of loss a simple one. The fuel used in all of the vapor loss tests was the previously designated standard vapor-lock reference fuel.

In the course of the normal evaporation loss studies, some thought was also given to the measurement of losses under the more extreme conditions encountered in city driving. With city driving involving a series of short runs, frequent stops and starts, intermediate periods of waiting, etc., it is naturally to be expected that losses in such service will be materially greater than those encountered in trip driving. A limited number of loss tests made in which the carburetor bowl samples were drawn after a rest period of from 30 minutes to an hour permits us to hazard a guess that normal city driving losses will be approximately two and one half times those observed in trip driving. This observation is, however, subject to further checking.

Octane-Number-Loss Procedure

A number of A. S. T. M. anti-knock determinations made on residual gasolines, prepared in the course of the laboratory studies on the vapor-loss method, indicated that vapor losses could be related to octane losses. Ten determinations made on residual samples of the 70-octane Ethylized vapor-lock reference fuel indicated a loss of from 0.25 to 0.3 in octane number for each percent loss in volume, or, in the more familiar terminology, a loss of one octane number per degree A. P. I. loss in gravity. This relationship was a consistent one for volumetric losses of 10 percent or less, although it is obvious that it is not a general rule and that it can only be accepted as valid for the test fuels used.

No attempt was made to measure the possible effects of volumetric losses on road octane numbers. However, since laboratory octane numbers do not bear too close a relationship to road octane numbers, we can probably look forward to some peculiar results whenever an attempt is made to demonstrate such effects.

RESULTS

The nine cars tested included those makes of low-, medium- and high-priced cars which are encountered in the largest number. For convenience in reference these cars have been assigned code letters from "A" to "H". All nine of the cars were examined to determine permissible-vapor-pressure-temperature curves when using the standard reference fuel. Eight of these cars were also examined to determine similar information when using the more volatile special reference fuel. In all cases, save two, permissible vapor-pressure information was obtained by more than one of the alternative methods previously described. Observations in the case of seven cars included, besides atmospheric temperatures, the temperature of the car tank, inlet and outlet temperatures at the fuel pump, carburetor-bowl temperature, and water jacket, under hood, and crank case temperatures. Six of the cars, two in the low-price bracket and four in the medium- to high-price bracket, were examined to determine volumetric losses from their respective fuel systems. Since a detailed description of the results on each car would be time-consuming, the discussion will be confined to typical results on representative cars followed by a summary of all results.

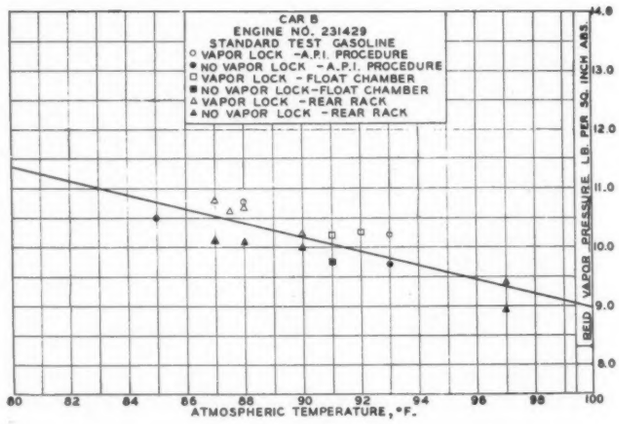


FIGURE 2

Maximum permissible Reid vapor pressure (corrected to sea level) as related to atmospheric temperature

Figure 2 shows the permissible vapor-pressure-temperature curve for car "B" when using the standard reference fuel. The corresponding curve for the considerably more volatile reference fuel is shown in Figure 3. This particular car is one of those from the low-price group. The similarity in the two curves is worthwhile noting; as, apparently, the volatility of the two fuels has had no influence on the results. The different fuel-handling methods employed in the tests are apparent from the designation of points. Good agreement between the various test methods will be noted.

Figures 4 and 5 are similar curves for a markedly different car. Car "D" is one of those in the higher-price bracket. Note the fact that in this case the permissible vapor pressures are considerably lower with the volatile test gasoline. It is probable that such dif-

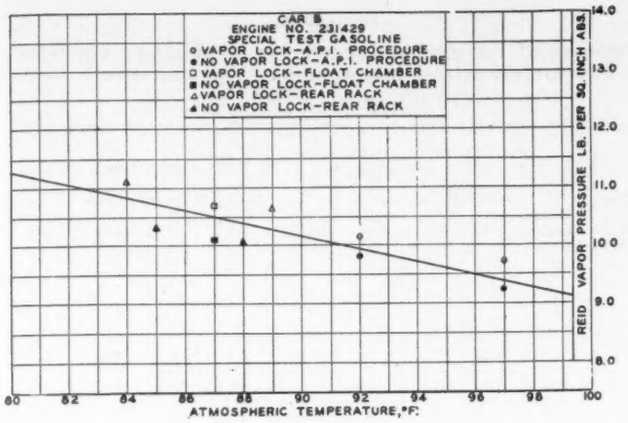


FIGURE 3

Maximum permissible Reid vapor pressure (corrected to sea level) as related to atmospheric temperature

ferences can be laid to peculiarities in the fuel systems since they can be accounted for in no other way.

These differences further indicate that vapor-lock test results, independently determined, will be virtually meaningless unless the test fuels used in the separate investigations are the same or nearly so. Since the choice of the reference fuels used in most current road-test work is based on the assumption that whatever is used should closely approximate current commercial quality, one wonders if this may be the soundest procedure. We know that fuel characteristics are changing. We also know that any conclusions which are based upon statistical average fuel qualities are liable to be meaningless whenever extreme products are encountred, and today's extremes may be a close approach to the average not many years hence. With this in mind, doesn't the more volatile reference fuel offer promise of more nearly accomplishing the desired result of sorting out fuel systems, because wastage of vapors results in lower permissible vapor pressures when fuels of considerable volatility are used in vapor-lock road tests?

Figures 6 and 7 show the permissible vapor-pressure curves for all cars tested with the two types of reference fuels. The most significant point in connection with these results is the variation in the slopes of the curves. These variations are sufficient evidence that the prediction of permissible vapor pressures for a range of temperatures from a single observation cannot

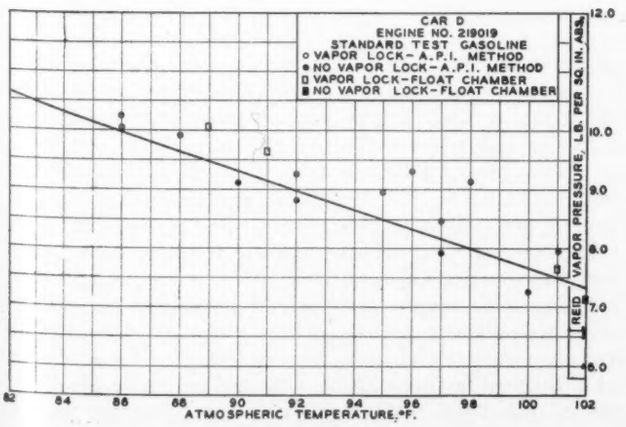


FIGURE 4

Maximum permissible Reid vapor pressure (corrected to sea level) as related to atmospheric temperature

be justified. Actual determinations will be necessary throughout the temperature range if cars are to be accurately rated.

To facilitate comparisons, all determined permissible vapor pressures for both types of reference fuels are presented in Table 1. Table 1 also includes limiting vapor pressures for 100°F. atmospheric temperatures, predicted by subtracting 1.2 pounds from the determined permissible vapor pressures for 90°F. operation. This is the extrapolation procedure generally employed in past road test work for arriving at a common basis of comparison for test results. Although some of these extrapolations are quite satisfactory, marked discrepancies between true and predicted values will be noted

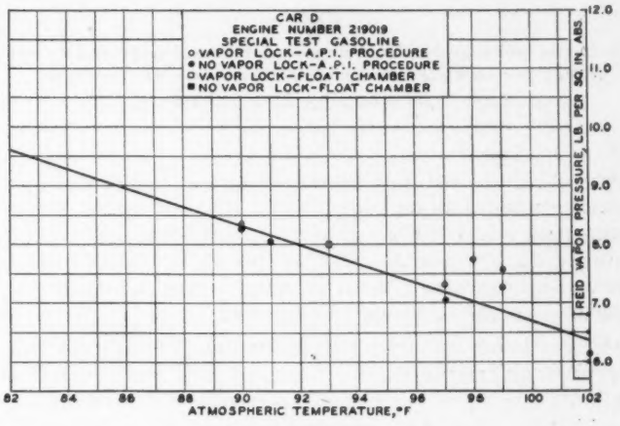


FIGURE 5

Maximum permissible Reid vapor pressure (corrected to sea level) as related to atmospheric temperature

in some cases. It is, therefore, easy to see where such predictions might be very misleading.

In considering all of these permissible vapor pressures, it should be kept in mind that the values are probably for a most extreme condition of driving. It has been observed that invariably cars in normal driving can handle considerably higher vapor pressures than

TABLE 1

Maximum permissible Reid vapor pressures as determined for all cars and fuels

Car Designation	Type Reference Fuel	Atmospheric Temperature, ° F.			Predicted* R.V.P. at 100 ° F.	Observed Slope or Conversion Factor
		80	90	100		
A	Standard...	12.23	10.62	9.04	9.42	0.158
A	Special.....	11.80	10.20	8.60	9.00	0.160
B	Standard...	11.38	10.15	8.96	8.95	0.119
B	Special.....	11.30	10.15	9.02	8.95	0.113
Br	Standard...	11.42	9.10	6.82	7.90	0.228
Br	Special.....	9.23	7.96	6.79	6.76	0.117
C	Standard...	12.00	10.12	8.92	8.92	0.120
C	Special.....	12.02	9.08	6.75	7.88	0.223
D	Standard...	....	9.30	7.70	8.10	0.160
D	Special.....	9.93	8.30	6.70	7.10	0.160
E	Standard...	10.87	8.82	6.80	7.62	0.202
E	Special.....	8.30	7.06	5.82	5.86	0.124
F	Standard...	....	9.27	7.93	8.07	0.134
F	Special.....	....	9.40	8.08	8.20	0.132
G	Standard...	11.47	9.90	8.35	8.70	0.155
G	Special.....	10.93	8.90	6.86	7.70	0.204
H	Standard...	....	10.01	8.20	8.81	0.181

* Determined by subtracting 1.2 pounds from the observed permissible vapor pressures at 90 °F.

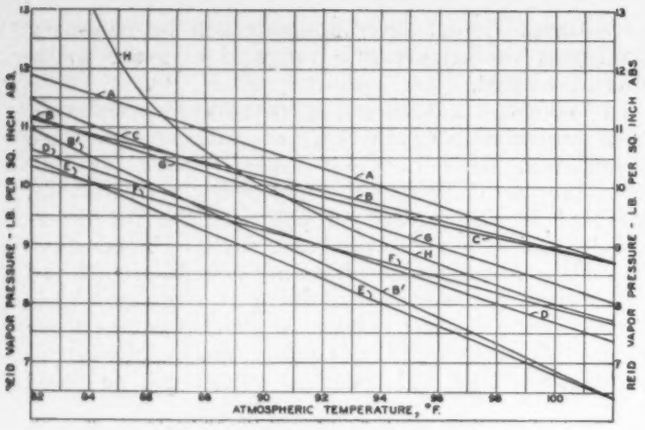


FIGURE 6

Maximum permissible Reid vapor pressures (corrected to sea level) for various atmospheric temperatures standard reference fuel plus butane

those indicated without encountering operating difficulties. It should also be remembered that the vapor pressures determined in the present instance are those for the car tank contents after vapor-lock observations. They are in no wise related to, or indicative of, required vapor pressures of fuels at filling stations.

A few brief remarks regarding the findings on the various modifications in test methods will be of interest. Each of the three alternative methods for arriving at permissible vapor pressures was found to be superior to the present tentative standard method from the standpoint of convenience and speed. As an example, the method embodying the proportioning valve was found to give results in form one third to one half the time normally required in the conventional method. Since the results obtained were in such good agreement, the great savings in time required to obtain full and complete information is sufficient incentive to warrant more attention being paid to these various modifications. These alternative methods should prove to be new and useful tools in vapor lock studies.

The various temperatures measured in the course of the tests were also correlated. Although the temperature measurements were made with all due care, there were many obvious irregularities. By plotting the observed temperatures for various points in the systems

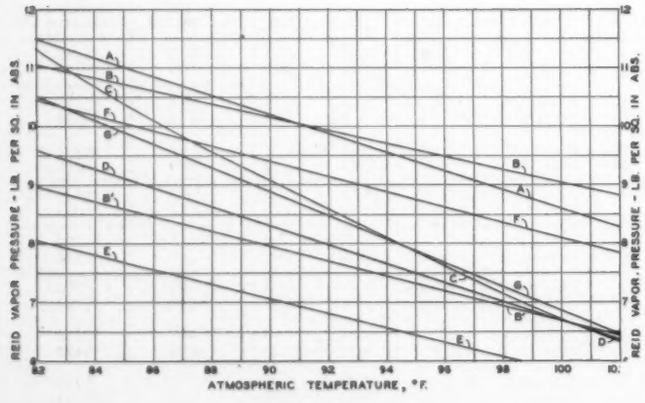


FIGURE 7

Maximum permissible R.V.P. (corrected to sea level) for various atmospheric temperatures special high volatility reference fuel plus butane

TABLE 2

Summary of fuel-system temperature observations (increase in temperature above atmospheric, °F.) atmospheric temperature range, 80-100°F.

Car Designation	Rear Tank	Stabilized at 55 Miles per Hour				After a 5 Minute Stop			
		Pump Inlet	Pump Outlet	Carburetor Bowl	Underhood	Pump Inlet	Pump Outlet	Carburetor Bowl	Underhood
A	6	18	24	26	35	37	30	31	44
B	1	33	27	31	35	32	38	36	55
C	7	27	35	24	15	38	80	42	48
D	2	28	46	42	19	48	92	46	42
E	4	25	26	30	29	27	66	45	42
F	5	31	41	41	52	37	40	53	51
G	9	22	32	34	44	39	41	42	68

against the simultaneously observed atmospheric temperatures, many of the apparent irregularities in the observed data could be eliminated by taking values from the best smooth curve through all the data. This scheme of handling is to be preferred because it avoids the necessity of attaching too much significance to any one measurement or to points obviously in error. Table 2 is a condensed summary of the figures obtained in

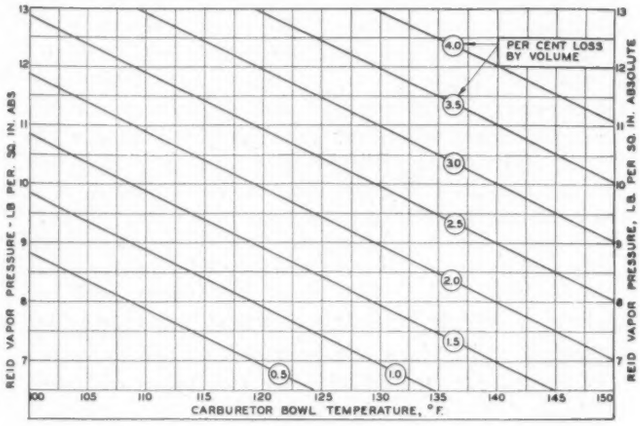

REID VAPOR PRESSURE - LB PER SQ. IN. ABS
REID VAPOR PRESSURE, LB. PER SQ. IN. ABSOLUTE
PER CENT LOSS BY VOLUME
CARBURETOR BOWL TEMPERATURE, °F.

FIGURE 8

Vapor losses from carburetor bowl as related to Reid vapor pressure and carburetor bowl temperature

this manner. Results are given in terms of the increase in temperature above atmospheric temperature. Particularly noteworthy are the high temperature rises encountered after the five-minute rest period in the case of cars "C", "D" and "E". In considering these temperature data, it should be kept in mind that the values are in the nature of statistical averages, that temperature rises greater and less than those shown were obtained in the tests. With temperature observations affected not only by instrument limitations, but also by such things as driving speed, wind velocity and direction, mechanical condition of the car, etc., it is clear that the statistically arrived at values should be used with extreme caution. The variations encountered between observations may also be accepted as evidence that little significance can be attached to single observations in any road test work. The more measurements that are made, the more reliable and trustworthy will the results be.

In exploring the range of losses as influenced by

TABLE 3

Probable vapor losses for conditions of steady driving at 55 miles per hour—all cars

(Losses in terms of volume per cent)

Car	Atmos. Temp. ° F.	Average Motor Fuel of 8.0 Pounds R.V.P.			Average Motor Fuel of 9.0 Pounds R.V.P.		
		Carburetor Bowl	Rear Tank	Overall	Carburetor Bowl	Rear Tank	Overall
A	90	1.02	1.40	2.42	1.52	1.66	3.18
	100	1.67	1.89	3.56	2.17	2.25	4.42
B	90	0.93	...	...	1.43	...	...
	100	1.55	...	...	2.05	...	...
C	90	0.65	...	...	1.15	...	...
	100	1.20	...	...	1.70	...	...
D	90	1.57	...	...	2.07	...	...
	100	2.20	...	...	2.68	...	...
E	90	1.00	1.30	2.30	1.55	2.30	3.85
	100	1.40	3.30	4.70	1.90	4.20	6.10
F	90	1.72	1.00	2.72	2.22	2.00	4.22
	100	2.33	2.70	5.03	2.80	3.70	6.50
G	90	1.40	1.50	2.90	1.90	1.85	3.75
	100	1.95	2.09	4.04	2.45	2.55	5.00

temperature, vapor pressure, and type of driving, two cars representative of the lower-price bracket and one in the high-price bracket were selected for a special series of exhaustive experiments. Loss determinations were made in each of these cases on the car-tank and carburetor-bowl liquids for a range of atmospheric temperatures when operating on the standard reference fuel of various vapor pressures. This standard fuel, because of its close resemblance to our present-day average summer gasoline, was found to be particularly well adapted to loss studies. Loss observations were made both for the condition of steady driving, with the bowl sample drawn while under way, and in a number of instances for conditions simulating town driving, in which case the bowl samples were drawn after a rest period of approximately one hour.

Because of the many variables influencing the magnitude of losses, plus the fact that losses are only significant when they are properly tied in with temperatures and with the permissible vapor pressure for those temperatures, it was not considered practical to present the individual loss determinations as such. Instead, we chose to crossplot these observations in various ways, as functions of fuel system temperatures, atmospheric temperatures, etc., in the hope of discovering some basic relationships. In exploring these possibilities, it was found that a common relationship appeared to exist for all cars between the carburetor-bowl temperature, the vapor pressure of the fuel in the car tank, and the loss from the carburetor bowl under conditions of trip driving. This relationship is represented in Figure 8. It was similarly found that the losses from the rear tank were closely related to the vapor pressure of the fuel in the tank and the existing atmospheric temperature, although this relationship was not common to all cars and, furthermore, did not appear to be as consistent as the one shown for carburetor-bowl losses. Separate charts of vapor pressure, atmospheric temperature, and loss from the rear tank were prepared for each of the cars tested and were used in conjunction with Figure 8. Although admittedly not as satisfactory as actual-loss measurements, such relationships do enable some interesting predictions as to the probable losses in trip driving where the information is limited. The predicted losses for all cars tested on which temperature data were available gave the results shown in Table 3. An indication of the reliability of this method of predicting losses can be gained from Figure 9 where the predicted over-all losses are compared with those actually determined. The predictions appear to be reasonably reliable.

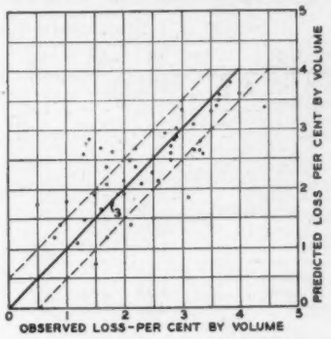


FIGURE 9

Overall losses—observed versus predicted values

For a more complete picture on representative cars, the smoothed-out normal loss observations for two cars in the extreme-price ranges are given in Tables 4 and 5. These are the minimum losses which can be expected in trip driving, with no stops between successive fillings of the fuel tank. In other words, over-all losses from the fuel system, when using the gasoline normally furnished for trouble-free operation at the atmospheric temperatures indicated, will approximate four percent in normal driving. Corresponding figures for the more extreme condition of town driving are not given. However, the limited number of determinations made for such conditions indicated that one might expect losses of the order of two and one half times those indicated for trip driving. All of these loss results can readily be converted to terms of probable octane number loss by applying the relationship previously described in the test procedure.

Before leaving this subject we have some further

TABLE 4

Predicted vapor losses for conditions of steady driving at 55 miles per hour—Car A

(Losses in terms of volume per cent)

Reid Vapor Pressure		Atmospheric Temperature, ° F.					
		80	85	90	95	100	105
7.5	Carburetor Bowl...			0.77	1.07	1.43	1.75
	Rear Tank.....			1.30	1.50	1.75	
	Overall.....			2.07	2.57	3.18	
8.0	Carburetor Bowl...		0.70	1.02	1.33	1.67	2.00
	Rear Tank.....		1.18	1.40	1.66	1.89	
	Overall.....		1.88	2.42	2.99	3.56	
8.5	Carburetor Bowl...		0.93	1.28	1.57	1.93	
	Rear Tank.....		1.30	1.50	1.80	1.96	
	Overall.....		2.23	2.78	3.37	3.89	
9.0	Carburetor Bowl...	0.88	1.17	1.52	1.83	2.17	
	Rear Tank.....	1.18	1.40	1.66	1.90	2.25	
	Overall.....	2.06	2.57	3.18	3.73	4.42	
9.5	Carburetor Bowl...	1.12	1.43	1.77	2.07		
	Rear Tank.....	1.30	1.50	1.80	2.08		
	Overall.....	2.42	2.93	3.57	4.15		
10.0	Carburetor Bowl...	1.35	1.67	2.02			
	Rear Tank.....	1.40	1.66	1.93		Vapor	
	Overall.....	2.75	3.33	3.95			
10.5	Carburetor Bowl...	1.60	1.93	2.25			
	Rear Tank.....	1.50	1.82	2.10		Lock	
	Overall.....	3.10	3.75	4.35			
11.0	Carburetor Bowl...	1.85	2.17				
	Rear Tank.....	1.66	1.95			Region	
	Overall.....	3.51	4.12				
11.5	Carburetor Bowl...	2.10					
	Rear Tank.....	1.83					
	Overall.....	3.93					

TABLE 5

Predicted vapor losses for conditions of steady driving at 55 miles per hour—Car G

(Losses in terms of volume per cent)

Reid Vapor Pressure		Atmospheric Temperature, ° F.					
		80	85	90	95	100	105
7.0	Carburetor Bowl...			0.90	1.20	1.45	1.70
	Rear Tank.....			1.25	1.46	1.77	
	Overall.....			2.15	2.66	3.22	
7.5	Carburetor Bowl...		0.88	1.15	1.45	1.70	1.98
	Rear Tank.....		1.20	1.38	1.63	1.90	
	Overall.....		2.08	2.53	3.08	3.60	
8.0	Carburetor Bowl...	0.88	1.15	1.40	1.70	1.95	
	Rear Tank.....	1.09	1.30	1.50	1.75	2.09	
	Overall.....	1.97	2.45	2.90	3.45	4.04	
8.5	Carburetor Bowl...	1.12	1.40	1.65	1.95		
	Rear Tank.....	1.21	1.40	1.70	1.96		
	Overall.....	2.33	2.80	3.35	3.91		
9.0	Carburetor Bowl...	1.38	1.65	1.90	2.20		
	Rear Tank.....	1.30	1.58	1.85	2.18		
	Overall.....	2.68	3.23	3.75	4.38		
9.5	Carburetor Bowl...	1.62	1.88	2.15			
	Rear Tank.....	1.45	1.75	2.04		Vapor	
	Overall.....	3.07	3.63	4.19			
10.0	Carburetor Bowl...	1.88	2.12				
	Rear Tank.....	1.60	1.92			Lock	
	Overall.....	3.48	4.04				
10.5	Carburetor Bowl...	2.12	2.38				
	Rear Tank.....	1.80	2.13			Region	
	Overall.....	3.92	4.51				
11.0	Carburetor Bowl...	2.38					
	Rear Tank.....	2.00					
	Overall.....	4.38					

remarks on rear tank losses. Although we had been led to expect that carburetor-bowl losses in the normal range of fuels would be of the order of 2 percent, we were frankly amazed to find the rear tank losses to be of almost equal magnitude. This is still a puzzling observation since the temperatures and vapor pressures under the test conditions do not appear sufficient to account for a loss of that magnitude. That these losses were real was accidentally demonstrated with one of the test cars. The car in question which repeatedly showed erratic rear tank losses was examined and found to be fitted with a special pop-valve type cap. This type cap was not regular equipment on that car but it did appear to have a measurable influence on losses. Whenever this cap was replaced with the conventional type vented cap, results immediately became more duplicable and exhibited orderly trends when plotted against vapor pressure and temperature. On the contrary, whenever the pop-valve cap was used the losses observed became both erratic and negligible.

CONCLUSIONS

The conclusions reached as a result of this series of road tests can be subdivided into those dealing with the subject of test procedure development and those of a more general nature.

The conclusions regarding test methods might be expressed as follows:

(a). Since the object of vapor-lock road tests is to study and properly classify fuel systems in the light of the fuels which they may be ultimately called upon to handle, it is probable that more consideration should be given to test-fuel characteristics. In this connection, it would seem that the adoption of more volatile reference fuels than those commonly employed might serve to indicate losses from fuel systems as well as yield the desired information as to permissible vapor pressures.

(b). Any of the road-test procedures will yield results sufficiently accurate and duplicable to be of value, provided sufficient care is taken and provided a sufficient number of observations are made. It is needless to add that the more tests made, the more significant will the results be.

(c). In determining permissible vapor pressures, actual observations must be made over the entire range of temperatures. Values for higher or lower temperatures than those encountered in the test cannot safely be predicted from any one observation.

(d). Alternative methods of handling fuels in vapor-lock road tests have promise of greatly simplifying the procedure. Further thought should be given to such ideas since it is not improbable that a simple fuel-system road-test procedure would ultimately be found as important and as useful a test as our present Reid vapor-pressure test for gasoline.

(e). The method for determining fuel losses, which is based on the observed differences in the specific gravities of samples taken from the car tank and the carburetor-bowl, has promise of meeting requirements for a simple and accurate loss test.

(f). The determined losses from the car tank appear to be related to the vapor pressures of the fuel and the atmospheric temperature, although the relationship is erratic and does not appear to be the same for all cars.

(g). The determined losses from the carburetor-bowl appear to be related to the vapor pressure of the fuel and the carburtor-bowl temperature. This relationship is a consistent one and appears to hold uniformly for all cars.

So much for the test methods. The conclusions pertaining to the actual test results are as follows:

(1) The permissible rear-tank vapor pressures for trouble-free operation under the worst conditions at an atmospheric temperature of 100° F. were found to range from 8.92 to 9.04 pounds for the three popular-priced 1937 cars. The values are those for normal summer gasoline. When more extreme fuels are used, the permissible vapor pressures range from 6.75 to 9.02 pounds.

(2) All but two of the remaining cars, i.e., cars in the intermediate and high-priced groups, showed permissible vapor pressures ranging from 7.93 to 8.35 pounds for trouble-free operation at 100° F. with average summer gasoline. With extreme products, the corresponding permissible vapor pressures ranged from 6.86 to 8.08 pounds.

(3) The two exceptions to the above were cars which showed permissible vapor pressures of 6.8 and 7.7 pounds on average gasoline with corresponding values of 5.82 and 6.7 pounds on the more extreme gasoline.

(4) The average temperature rises through the fuel systems of 1937 cars, as determined by taking values from the best smooth curve through all temperature observations, do not appear to be materially different from those reported in the past for earlier models.

(5) Under the condition of trouble-free operation, the losses through evaporation from fuel systems are of sufficient magnitude to warrant attention.

(6) Indications are that the over-all losses from representative fuel systems, when using the gasoline normally sold for the atmospheric temperatures then prevailing, will range from approximately 4 percent to some higher value, depending upon the "trouble-free vapor pressure requirement" of the car in question and upon the type of driving.

(7) Starting with an over-all loss of approximately 4 percent as average for cars with trouble-free vapor pressure requirements of 8 to 9 pounds, the probable loss appears to increase at the rate of 1 percent additional for each drop of 1 pound in the "trouble-free vapor pressure requirement." These losses are minimum losses, i.e., losses for the condition of trip driving on present average summer gasoline. The losses to be expected for the condition of about town driving are substantially greater, a limited number of observations indicating that they would be of the order of two and one half times those reported for trip driving.

(8) The corresponding over-all loss in octane number will be appreciable. A drop of 0.25 to 0.3 A. S. T. M. octane number per percent loss through evaporation appears to be the least that could be expected from these tests. This means that the A. S. T. M. octane number drop suffered on summer gasoline in cars having vapor pressure requirements of 8 to 9 pounds will be approximately one unit while losses of two units could conceivable be expected in the case of cars of extremely low "trouble-free vapor pressure requirement."

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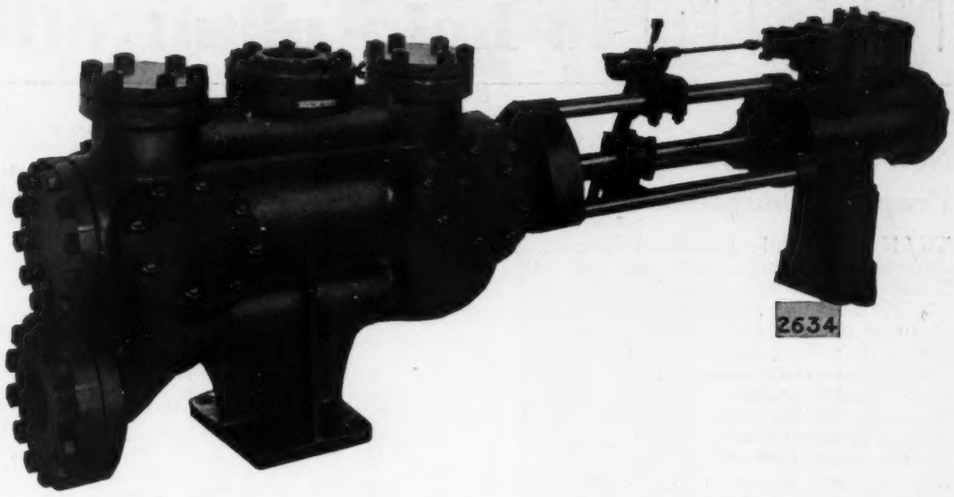
"ACE" TYPE

TRANSIT'S modern, high efficiency, close clearance pump for butane, propane, gasoline and other volatile liquids.

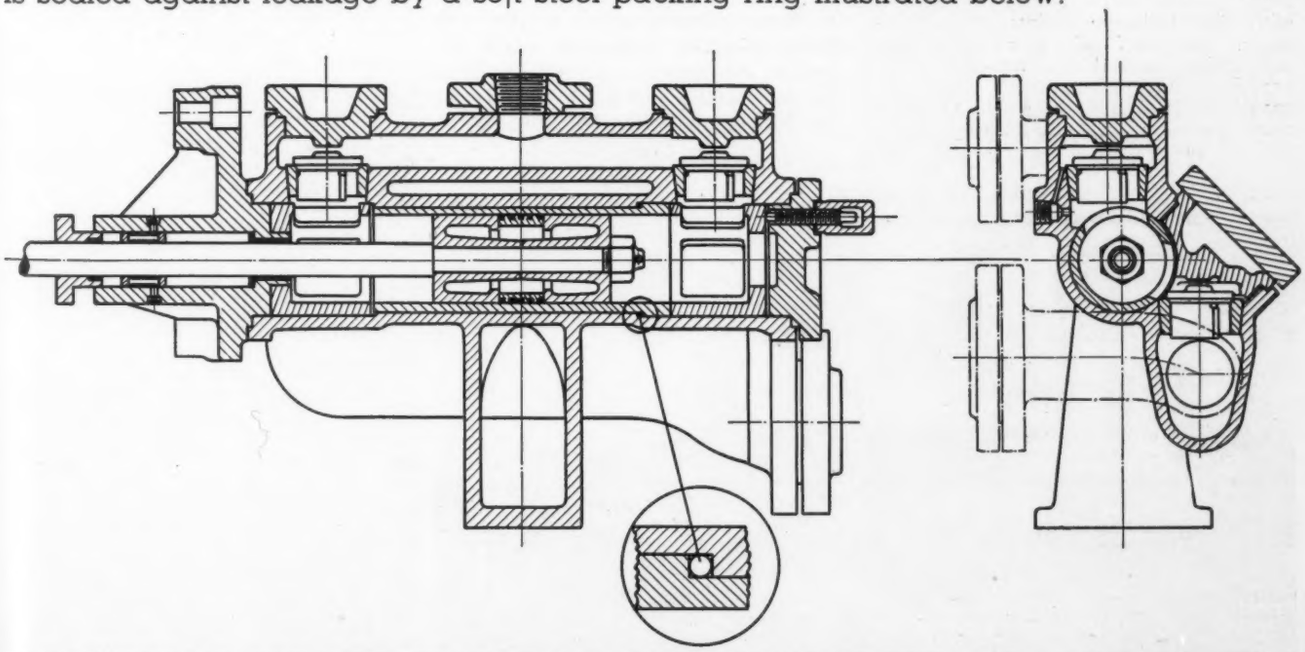


Minimum clearance is obtained by locating the suction and discharge valves very close to the cylinder bore, and using a piston designed to fill the piston clearances.

All valve seats are in a horizontal position, the valves themselves operating vertically. This insures an even distribution of wear and perfect seating—a feature not found in some other pumps of this type.

Suction valve covers are inclined 45°. By removing these covers the suction valves are exposed for inspection or repair. This permits using standard valves and seats for both suction and discharge and which are interchangeable with each other. Double suction valve area provided on large sizes.

Cylinder liner is easily removable and held in place by short, packed set screws. Liner is sealed against leakage by a soft steel packing ring illustrated below.



NATIONAL TRANSIT PUMP AND MACHINE CO., Oil City, Pa.

NEW YORK - PHILADELPHIA - CHICAGO - CLEVELAND - PITTSBURGH - LOS ANGELES - HOUSTON - TULSA

Frick-Reid Supply Corporation
108 N. Trenton Avenue,
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The Lang Company
267 West First South St.
Salt Lake City, Utah

Standard Supply and Hardware Company
822-838 Tchoupitoulas St., New Orleans, Louisiana

Pratt-Gilbert Company
Phoenix, Arizona

TRANSIT Pump & Engine Co.
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Reeves & Skinner Machinery Co.
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19 Main St.,
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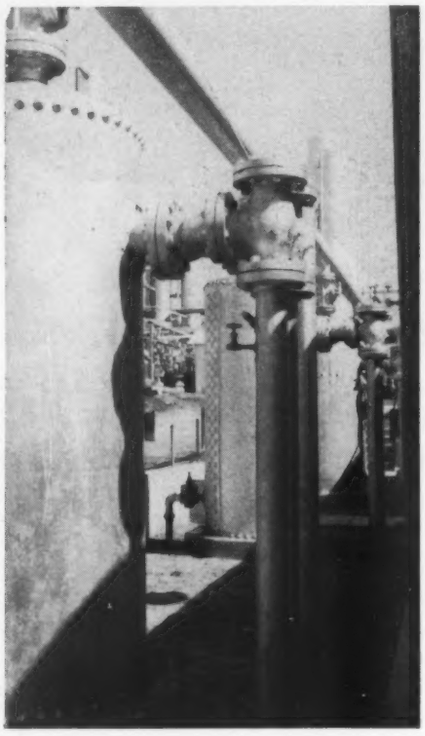
IDEAS to help plant efficiency . . .

New Type Hook-Up On Propane Compressors

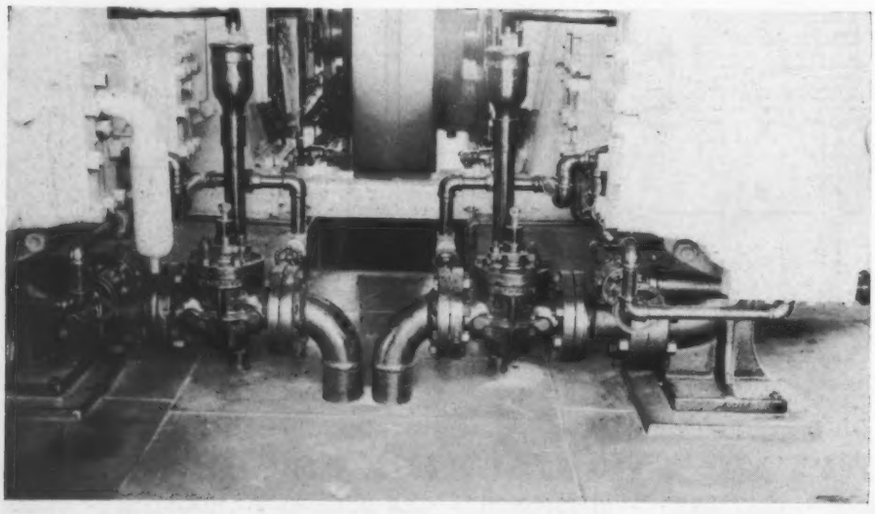
WHEN Parade Gasoline Company revamped its gasoline plant in East Texas so that refrigeration could be used for reducing the temperature of the absorption oil, a separate engine room was built and equipped with four twin gas engine-driven compressors. However, some changes were made in the discharge piping hook-up which provides a greater capacity and at the same time prevents gas from flowing back to the cylinders when an engine is shut down, or stops running for any reason.

The usual exhaust stool provided for small pipe diameters used in high-pressure work was used with lubricated plug valves flanged to the elbow stool. Instead of connecting both exhaust fittings to each other with the usual tee and single discharge pipe line leading to the scrubbers, individual piping was installed for each cylinder. The practice commonly followed in other plants which included laying the lines beneath the concrete floor was adopted, but scrubbers were set just outside the building. Each scrubber, one provided for each of the four engines, has a single inlet flanged fitting, with a flanged Y bolted to it. In turn, a pair of piston type relief valves were bolted to this Y with the discharge piping attached to them. The relief valves are units having spring backed pistons with compression rings which open when the gas flows through them, but the moment a compressor is taken out of service, the pressure drop back through and across the piston valves permits them to close.



Discharge connections on scrubbers in Parade Gasoline Company which are used on Propane refrigeration units so that valve action will not be interferred with by gas fluctuating from one cylinder to another.

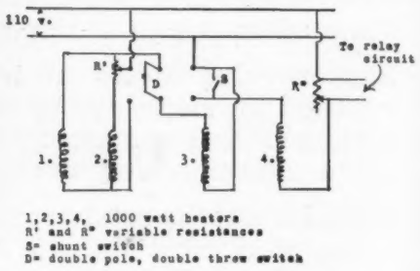
Greater capacity is claimed for this installation, with freer action of the cylinder discharge valves than with the single discharge line. Greater safety is apparent due to the automatic action of the relief valves attached to the scrubber. Separate thermometer wells provide for individual discharge temperature readings.



Discharge connections on compressor units which handle propane for refrigeration in Parade Gasoline Company's E-Tex gasoline plant that prevents valve interference by gas discharging through separate sets of piping.

Electrical Heating Circuits

AN oil bath used in conducting oxidation tests at 120°C. had to be pressed into service to operate at 200°C. The original circuits did not provide for such a high temperature and a method was required for modifying the hook-up so that either temperature could be obtained without difficulty.



1,2,3,4, 1000 watt heaters
R' and R" variable resistances
S= shunt switch
D= double pole, double throw switch

The change-over shown in the diagram required only the addition of a double-pole, double-throw switch and a shunt switch. A temperature of 120°C. is maintained with the D. P. D. T. switch to the right and the shunt open. A 200°C. temperature is reached with the D. T. switch reversed and the shunt closed.

Olean, N. Y. G.F.F.

Instrument Board and Sliding Window

WHEN Warren Petroleum Company reconditioned its gasoline plant at Maude, Oklahoma, to process natural gasoline for the manufacture of butane for drilling engines, instruments were placed at the base of the column. Mounted upon the usual type of wood backed protective housing, the front door, or window was attached so it could be moved upward to close the meter house, or slipped down when weather permits it to remain open.

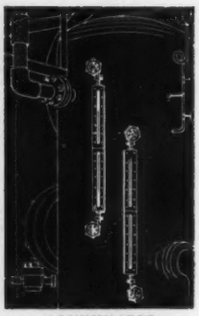
In so many installations of this type, hinges are used either at one side or an end for opening or closing, with winds given an opportunity to swing it violently back and forth. In this particular instance, the action of the window when being closed or opened prevents breakage of glass because it is always retained in guides. Screen sash hooks

PENBERTHY
Reflex Gages

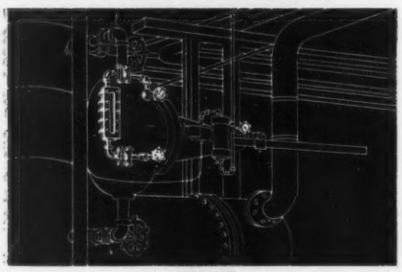
(Licensed under Jerguson Patent)

have many refinery and natural gasoline plant applications

VAPOR RECOVERY

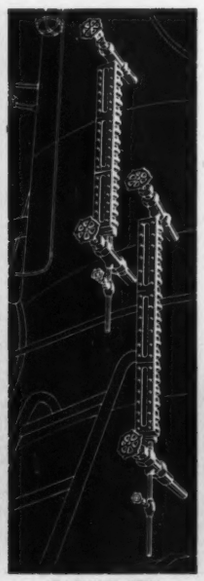


ACCUMULATOR TANK

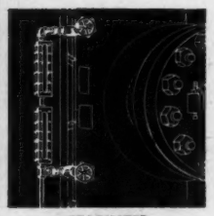


REBOILER

VAPOR SEPARATOR



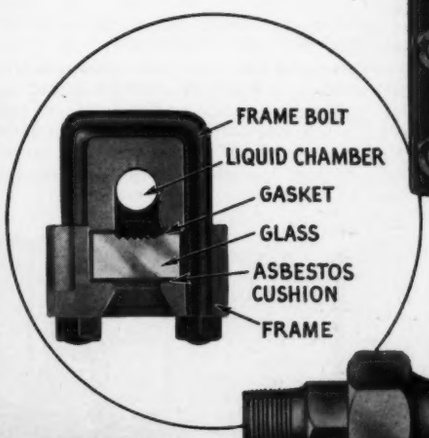
CRACKING STILL



STABILIZER

● The sketches show only a few of the many important applications for Penberthy Reflex Gages in oil refineries and natural gasoline plants. As a matter of fact, Penberthy Reflex Gages are preferred wherever a liquid level must be easily and positively visible . . . when that liquid is under pressure or at high temperature (or both).

Penberthy Reflex Gages are of exceptionally rugged construction; they are made in any length desired and for various kinds of liquids. We shall be glad to quote upon your requirements.



MULTIPLE TYPE EQUIPPED WITH DROP FORGED STEEL GAGE VALVES

PENBERTHY PRODUCTS

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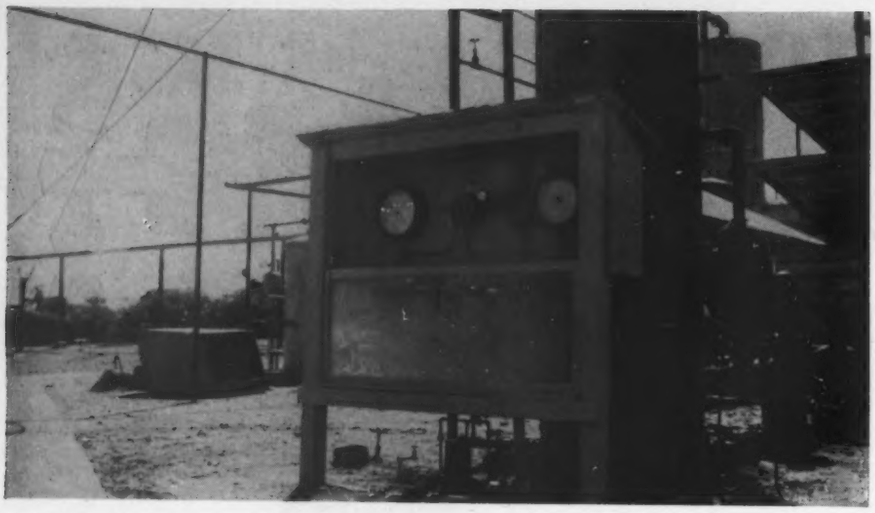


Instrument box made with sliding window in Warren Petroleum Company gasoline plant at Maude, Oklahoma.

were placed at the top so it may be securely fastened when closed, and the guides are made so the sash falls entirely below the opening in the building so operators may change recorder charts or make adjustments easily.

Method for Cleaning Copper Dishes

THE copper hemispheres which are used in determining gum in gasoline must be cleaned thoroughly and polished between each determination. This process is a very laborious one if steel wool is used alone.

If the dish is first cleaned thoroughly with acetone, then dipped in a weak solution HCl and while still wet with this solution is polished with steel wool, the acetone removes all the gum which has collected in the dish. The HCl dissolves most of the corrosion which has formed on the dish, and the action of the steel wool loosens the corrosive material which still adheres.

After the dish has been thoroughly cleaned in this manner it is washed with distilled water and thoroughly dried. This washing must be thoroughly done in order to remove all chemicals used in the process of cleaning, for if not removed, they will cause erroneous results in the determination.

Arkansas City, Kansas. W.N.E.

Suspended Transmission Lines

SINCE it is much easier to trace a pipe line that is located where it can be easily seen, Phillips Petroleum Company has adopted a policy of carrying all gas, steam, vapor and gasoline lines above ground, and suspended from piping high enough that any field truck may be driven beneath them with safety.

Piping is cut the required length and set in concrete with risers located far enough from each other to accommodate desired number of pipe lines. A cross member is welded across the tops of these risers with holes burned with a torch, or drilled to take eye bolts with adequate capacity to carry any pipe required of them. Bands are made for each size pipe, made in half sections with bolts in each end of a pair so they can be taken apart quickly. When assembling the piping, the bands are clamped around them just below the cross member supports. A short length of chain is used to connect between the eye of the bolt and the top bolt of the pipe line clamp, thus supporting the transmission pipe and allowing it perfect freedom to expand and contract lengthwise without placing a strain upon any part of the system.

Localizing Soldering Heat

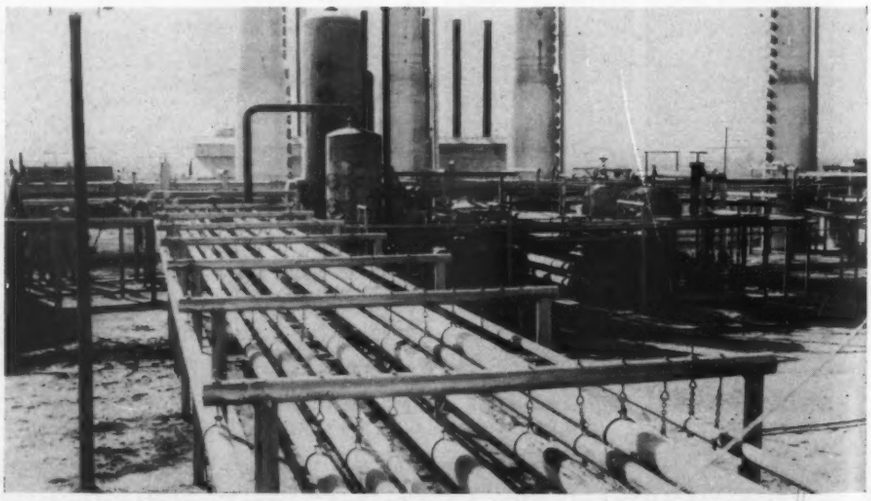
SOLDERING of new leads to thermocouples must be done without heating the pair sufficiently to start separation of the junction between the two metals; the usual method being to use a heavy copper and apply on the outside of the wire which is merely stuck to the outer surface at the outer end. If the 'couple be held in a vise for this work, the metal of the jaws will conduct heat away from the 'couple and require additional or prolonged application of the copper to overcome this loss, frequently with loosening of the junction.

By cutting two squares of asbestos sheet packing, and bending them outwardly so as to rest atop the vise jaws, the element of the 'couple can be held rigidly enough for working, yet be insulated against heat loss, enabling the new leads to be quickly attached.

Such a lining for the vise jaws also is of aid in another maintenance chore: that of retipping Bourdon tubes from gauges. Most of these tips are soldered in place, save on highest pressure-type gauges and the solder joint will need

Two squares of asbestos packing prevent heat loss when soldering.

renewing, or the tip resetting to care for service wear, at which time the job can be more neatly and expeditiously performed if the bend tube be held in a vise between asbestos pads, the packing material serving to prevent flatting of the tube—and consequent introduction of erratic readings—and also localizing the heat so that a full sweat joint can be made between tube and tip.



Steam, gas, vapor and gasoline lines hanging from chain supports in Phillips Petroleum Company's Edmond, Oklahoma plant.

Oil Show

(Continued from page 177)

Mid-Continent area and in the exposition. There will be several meetings held especially for these delegates and the Tulsa Rotary Club will honor these delegates at an international luncheon. The entertainment of this group will be handled by Gardner's committee.

Old Timers

H. R. Gruber, vice president in charge of oil country sales for Union Wire Rope Corporation, and chairman of the "Old Timers" committee for the exposition, has announced that his committee will see that the pioneers of the industry are properly honored.

The historical, under C. L. McMahon, is the subcommittee which receives applications and nominations for the honorary titles of "Grand Old Man of the Petroleum Industry" and "Grand Old Man of Tulsa." McMahon said that nominees for the "Grand Old Man of the Industry" award must have been actively engaged in the oil business for 50 years or more while aspirants for the title of "Grand Old Man of Tulsa" must have been actively engaged in the oil business for 30 years and in Tulsa for 20 years. Awards will be made during the exposition.

The memorial sub-committee, under J. P. Flanagan, have completed its plans for a memorial to the memory of the pioneers of the petroleum industry who have passed on and in honor of those who are yet alive. The memorial will be placed in the sunken gardens, at the south end of the cafeteria, and will be officially dedicated Sunday, May 15. A vault, which will be in the base of the memorial will contain the history of the pioneer oil men and the names of these pioneers who have attended the oil show. Once every two years during the "Old Timers" ceremonies at each exposition, the vault will be opened and additions will be made to each of the records.

Only the base of the monument will be erected this exposition.

The registration committee will, through its work during the oil show when it registers all of the "Old Timers" who attend, provide one of the records which will be kept in the vault of the memorial.

The replica of the Drake Well will serve as a club house for the Old Timers.

Committee Chairmen

Committee chairmen are Scientific and Technical, Dr. Gustav Egloff; Old Timers, H. R. Gruber; Local Hosts, R. O. Dietler, Stanolind Crude Oil Purchasing Company; Production, H. M. Stalcup, Skelly Oil Company; Marketing, R. W. McDowell, Mid-Continent Petroleum Corporation; Exploration, Luther H. White, Deep Rock Oil Company; Purchasing Agents, H. M. Cosgrove, Purchasing Agents Association Secretary; International Delegates, James H. Gardner; Transportation, A. F. Winn, Skelly Oil Company; Housing Bureau, Earl Sneed, Sneed Royalty Company; Drilling Contractors, C. F. Camp, Arrow Drilling Company; Safety Day, J. D. McCamey; Pipe Line, W. R. Finney, Oklahoma Pipe Line Company; Natural Gasoline, J. A. LaFortune, Warren Petroleum Corporation; C. M. Boggs, Kanotex Refining Company.

The Look Box

Conventions

MAY 11–13	Natural Gasoline Association of America, Tulsa, Oklahoma
14–21	International Petroleum Exposition, Tulsa, Oklahoma.
23–25	American Petroleum Institute, Eight Mid-Year Meeting, Wichita, Kansas.
27–28	Annual Petroleum and Natural Gas Conference, Penn. State College, State College, Pa.
JUNE 6	Oil Workers International Union, Houston, Texas.
12–17	Society of Automotive Engineers, Summer Meeting, The Greenbriar, White Sulphur Springs, West Virginia.
15–18	American Society of Mechanical Engineers, National Oil and Gas Power Meeting, Dallas, Texas
16–18	Pennsylvania Grade Crude Oil Association, Pittsburg, Pa.
20–24	American Society of Mechanical Engineers, St. Louis, Mo.
JUNE 21–JULY 1	American Society for Testing Materials, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
SEPT. 14–16	National Petroleum Association, Hotel Traymore, Atlantic City, N. J.
5– 9	American Chemical Society, Milwaukee, Wisconsin.
NOV. 14–18	American Petroleum Institute, Stevens Hotel, Chicago.

A.P.I. Refining Division Technical Program

HIGH technical papers on petroleum refining, research, fire and accident prevention and related subjects are scheduled in the program for presentation before the Refining Division, American Petroleum Institute's Eighth Mid-year Meeting at Wichita, Kansas, May 23, 24 and 25. Two hotels will be used for the sessions this year. The three group sessions of the Refining Division, divisional committee meetings and meetings on fire and accident prevention will be held in the Lassen Hotel, where will be a branch registration and information desk. In the Allis Hotel the institute headquarters and registration desk and press room will be located and all meetings pertaining to the production branch will be held in the Allis.

The program follows:

Tuesday, May 24, 10 A. M.

"Elements of Waste-Water Separator Design. A Report of an Investigation Using a Model Separator," W. B. Hart, The Atlantic Refining Company, Philadelphia.

"The Use of Sodium Phenolate for Hydrogen-Sulfide Removal," G. M. Garvlin, The Koppers Company, Pittsburgh.

"The Girbotol Purification Process," W. R. Wood and B. D. Storrs, The Girdler Corporation, Louisville, Kentucky.

"The Purification of Gases by the I. G. Alacid Process and the Recovery of Sulfur by the I. G. Claus Process," Hans Baehr, Germany.

"The Shell Phosphate Process for Removal of Hydrogen Sulfide," T. W. Rosebaugh, Shell Development Company, Emeryville, California.

Tuesday, May 24, 2 P. M.

"The Removal of Inorganic Salts from Crude Petroleum," W. P. Hawthorne and H. L. Bedell, Socony-Vacuum Oil Company, Augusta, Kansas.

"Laboratory Control of De-Salting Processes and of the Corrosion of Distillation Equipment," L. L. Davis, Continental Oil Company, Ponca City, Oklahoma.

"Identification and Properties of Straight-Run and Cracked Residue," A. H. Bachelder and H. B. Wellman, Standard Oil Company of California, San Francisco.

"The Catalytic Hydrogenation of Octenes to Octanes," Shell Development Company, Shell Chemical Company and Shell Oil Company, San Francisco.

"The Anti-Knock Requirements of Automobiles," T. B. Rendell, L. E. Hebl and R. J. Greenshields, Shell Petroleum Corporation, Wood River, Illinois.

Wednesday, May 25, 10 A. M.

"Application of Bailey's Theory of Tube-Stress Calculations," C. O. Rhys, Standard Oil Development Company, Elizabeth, New Jersey.

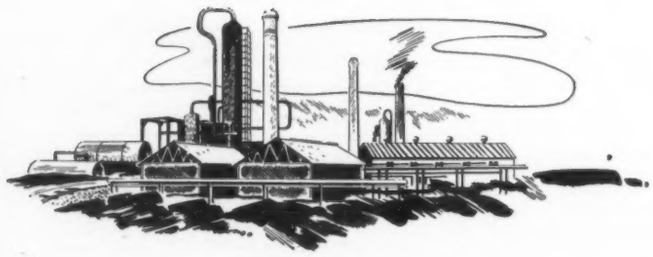
"Closures for High-Pressure High-Temperature Operations," Fred Key, Key Company, East St. Louis, Illinois.

"New Developments in Petroleum Storage Vessels," D. E. Larson, Chicago Bridge & Iron Company, Chicago.

"Nickel-Bearing Alloys Used in Petroleum Refining," B. B. Morton, International Nickel Company, Inc., New York.

FOR COMBINATION SELECTIVE CRACKING. . . FOR STABILIZING. . . FOR RECOVERY. . . . FOR ATMOSPHERIC DISTILLATION . . .

FOR TODAY'S REFINING METHODS . . . PRECISION CONTROL BY *Taylor*



6 WAYS IN WHICH TAYLOR

New refining methods demand modern instruments. In providing instruments for precision control of temperature, pressure and flow for these methods, Taylor has pioneered. Here are some of its achievements:

FULSCOPE CONTROLLER with the Universal Sensitivity Adjuster, the first graduated dial with infinite positions of sensitivity for obtaining the best throttling range for every job. An original Taylor feature.

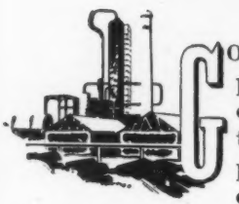
PRECISION VALVE ACTION. Originally an inbuilt part of the Taylor Dubl-Response Control Unit, this was later made available in a separate unit, the Valv-Precisor.

THERMOSPEED. Taylor led the way in developing greater speed for tube system response when separable wells are used, as they always are in refineries.

ACCURATUS TUBING permits the use of the all-steel welded tube system, automatically compensated, without loss of the advantages of mercury as

FOR VACUUM DISTILLATION. . . FOR ATMOSPHERIC-VACUUM DISTILLATION. . . FOR SOLVENT DEWAXING

FOR PROOF, see installations in outstanding plants of every type . . . Finest engineering skill plus finest instruments for temperature, pressure and flow control help raise refining efficiency and product quality



Go down the line of refining processes — atmospheric distillation, vacuum distillation, combination atmospheric-vacuum distillation, combination selective cracking, solvent dewaxing. One fact stands out.

Go down the line of leading refiners using any of these different methods. One fact stands out again. And here it is: That Taylor Systems provide control of temperature, pressure and flow most dependably and economically.

A GLANCE AT THE RECORD

Let's be specific. Let's look at a few examples of how Taylor engineering plus Taylor Instruments has brought new high operating efficiency to refining plants.

Here's a 16,000-barrel combination selective cracking unit. Its initial firing run was 34 days. All guarantees of capacity and products were met without a single barrel of off-specification products! Taylor Instruments provided the precise control of temperature and flow that helped make this record possible.

Another plant, designed to operate on Mid-Continent and Corning crudes, ran continuously for 39 days on its first firing, making specification products at guaranteed capacity. Temperature, pressure and flow are Taylor-Controlled.

On an atmospheric-vacuum distillation unit in the Mid-Continent field, Taylor Systems maintained temperatures, flows and pressures within such close limits that the end points of the products were held more constant than thought possible. These results led the engineering company to specify Taylor Controls in four more atmospheric-vacuum units for four other oil companies.

In solvent dewaxing, Taylor Controllers maintain the outlet temperatures of double-pipe chillers in eight of the country's most modern plants. Other temperatures and pressures in the process are also Taylor-controlled.

MORE AND MORE PLANTS TURN TO TAYLOR

These are only a few examples of what Taylor has done—and can do in your plant. Taylor engineers will bring to your particular problems thorough knowledge of any refining process. And the instruments Taylor engineers install are the finest of their type—in design, in workmanship, in the service they give.

To take advantage of the services of Taylor engineers—offered to you without charge—and to obtain further information about Taylor Instruments and Systems, get in touch with a Taylor representative. Or write to Taylor Instrument Companies, Rochester, New York or the nearest local office. Manufacturers in Great Britain—Short & Mason, Ltd., London, England.

See Our Exhibit
INTERNATIONAL PETROLEUM EXPOSITION
TULSA
MAY. 14-21

HAS PIONEERED

the actuating medium. Until its introduction, mercury tube systems longer than 25 feet were unsuccessful. Now lengths one hundred feet and over are not unusual.

MOTOSTEEL EVENACTION MOTORS. Taylor was the first to use the all-steel welded valve motor, both stronger and lighter than older types.

INDUSTRIAL THERMOMETERS with BINOC Tubing make temperature-reading easier . . . end guessing. BINOC Tubing provides 2 to 5 times greater visibility of the mercury column and eliminates bore reflections.

Taylor

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TEMPERATURE, PRESSURE, FLOW *and* **LEVEL INSTRUMENTS**

Forecast of Demand for Motor Fuel and Crude Oil, May, 1938

THE DAILY average supply of domestic crude oil estimated by the Bureau of Mines to meet the market demand in May, 1938, is 3,318,100 barrels. This is 43,600 barrels less than the estimate for April 1938, 259,700 barrels (7 percent) less than the actual daily production for May 1937, and 4 percent less than the demand for domestic crude for that month. Normally, demand in May is substantially higher than in March and April, but this year the situation will be modified by several abnormal factors chief of which are the record-breaking gasoline stocks, the failure of gasoline demand to show more than a slight increase over 1937, and the decline in demand for all fuel oil, which is about 8 percent less than last year. Total stocks of all oils on February 28, 1938, were 56 million barrels higher than at the same time last year; of this increase about 11 million was in California and 45 million in districts east of California.

Crude-oil production during the 4 weeks March 12 to April 9 averaged 3,408,000 barrels daily. During this period crude-oil stocks increased 1,990,000 barrels, 198,000 barrels of which was in foreign stocks, leaving an increase of 1,792,000 barrels for domestic grades. The subtraction of this amount from production leaves 3,344,000 barrels as the daily average demand for domestic crude oil.

Motor Fuel

The estimate for domestic motor fuel demand for May is 46,800,000 barrels, or 3 percent higher than the actual demand for May 1937.

Motor-fuel exports, based upon less optimistic returns by exporters, have been estimated as 3,100,000 barrels. This is 200,000 barrels less than the estimate for April, and 233,000 barrels less than the actual exports for May 1937.

Stocks of finished and unfinished gasoline amounted to 92,280,000 barrels on February 28, 1938. According to statistics of the American Petroleum Institute, these stocks increased 1,581,000 barrels during March, bringing them to approximately 93,900,000 barrels as of March 31, 1938. During the first two weeks in April they have declined about 900,000 barrels, compared with the bureau's estimate of 2,500,000 barrels for the month. Crude runs to stills for the 4 weeks March 19 to April 16 averaged about 3,120,000 barrels daily, compared with 3,158,000 barrels in January and 3,149,000 barrels in February. This unseasonal decline in runs indicates a desire on the part of refiners to reduce gasoline inventories by curtailing runs. Accordingly, the bureau estimates that finished gasoline stocks will decline 3,350,00 barrels, compared with an actual decline of 1,150,000 barrels in May 1937.

Benzol and "direct" sales and losses of natural gasoline have been estimated as 1,050,000 barrels, making the estimated production of gasoline 45,500,000 barrels. This is distributed among the various districts as follows (thousands of barrels): East Coast, 6,520; Appalachian, 1,580; Indiana-Illinois, 7,940; Oklahoma, 2,440; Kansas-Missouri, 2,430; Inland Texas, 3,670; Texas Gulf Coast, 11,110; Louisiana Gulf Coast, 1,420; North Louisiana-Arkansas, 940; Rocky Mountain, 1,110; California, 6,340.

Crude Petroleum

Natural-gasoline consumption at refineries in May is estimated as 5.8 percent of the total gasoline required, or 2,640,000 barrels. The yield of straight-run and cracked gasoline is estimated as 44.3 percent, compared with 44.2 percent for April. The application of this yield to the estimated straight-run and cracked gasoline production of 42,860,000 barrels gives refinery crude-oil requirements as 96,760,000 barrels, or 3,121,000 barrels daily.

Foreign crude run to stills is estimated at 2,100,000 barrels, the same as estimated for April.

The estimate for crude-oil exports has been increased 50,000 barrels over the April figure to 6,100,000 barrels. Although this is a net increase for the country as a whole, the estimate for California has been decreased because of expiring and unrenewed contracts for exports.

Houston Technical Club Is Organized

THE Houston Technical Club was organized March 28 at a meeting attended by over 50 men identified with the petroleum industry.

I. W. Alcorn, engineer with The Pure Oil Company was elected president. H. O. Sears, Alliger & Sears Company, was named vice president. The secretary and treasurer is O. A. Schilling of Mid-Continent Supply Company.

EMBY KAYE

Vice president in charge of manufacturing for Skelly Oil Company at Tulsa has resigned effective April 1 to join Wasatch Oil Refining Company and allied interests of Salt Lake City, Utah. He will actively head the new expansion program of the company which includes construction of refineries at Pocatello, Idaho, and at Spokane, Washington. Wasatch Oil Refining Company has operated a refinery at Ogden, Utah, for the past several years.

—Alvin Krupnick

I. W. ALCORN

Division production engineer in the Gulf Coast for The Pure Oil Company, Houston, who was elected president of the newly organized Houston Technical Club, is a graduate of the Missouri School of Mines and Massachusetts Institute of Technology. He commenced his career in the oil industry at Burbank, Oklahoma, being associated with Independent Oil & Gas Company (now Phillips Petroleum Company) in various engineering capacities. He organized the concern's production engineering department under C. P. Dimit. Later he joined Smith Separator Company and Oil Well Supply Company, before joining The Pure Oil Company.

The Houston Technical Club was formed along lines similar to the successful Tulsa Technical Club. Membership is limited to those connected with the operating departments of oil and refining companies, and to equipment suppliers and their representatives.

It is planned to hold meetings on the last Monday of each month at the Ben Milam Hotel, Houston, at which a short instructive program will be presented following dinner. Aggressive efforts are to be made to increase the membership of the club among oil and refining companies, so that the monthly meetings may serve as a clearing house for information of both engineering and practical nature.

Hill Heads Refining Program Committee

J. BENNETT HILL, Sun Oil Company, Marcus Hook, Pennsylvania, has been appointed chairman of the 1938 Program Committee of the American Petroleum Institute's Division of Refining. Announcement of his appointment was made by W. S. S. Rodgers, of The Texas Company, New York, Institute vice president for refining. R. P. Anderson, secretary of the

Thicknesses from 1/64" to 1/4". Sheets 40" x 40" and larger.

Garlock 7021

PACKING, like wrestlers, has to be plenty tough to withstand the grueling punishment handed out these days. To stay in the front ranks and stand out above the crowd, both must have "what it takes."

GARLOCK 7021 Compressed Asbestos Sheet Packing does have "what it takes." It has never been downed by any gasketing job. It stands up against the most severe conditions, such as super-heated steam and light oils at high temperatures. When ordinary gasketing materials fail GARLOCK 7021 can be depended upon.

Don't let the expense of gasket failures get you down. Use GARLOCK 7021 and stay on top! It's a winner—always! Order a supply today and be prepared for any emergency by keeping it on hand at all times.

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Institute's Division of Refining, was named secretary of the committee. Members of the committee are:

H. W. Camp, Cities Service Oil Company, Tulsa; T. G. Delbridge, The Atlantic Refining Company, Philadelphia; R. A. Halloran, Standard Oil Company of California, San Francisco; R. E. Haylett, Union Oil Company, Los Angeles; E. W. Isom, Sinclair Refining Company, New York; and E. A. Lacomble, Shell Petroleum Corporation, St. Louis.

Also N. E. Loomis, Standard Oil Development Company, New York; K. G. Mackenzie, The Texas Company, New York; Walter Miller, Continental Oil Company, Ponca City; G. G. Oberfell, Phillips Petroleum Company, Bartlesville; J. B. Rather, Socony-Vacuum Oil Company, New York; Herschel G. Smith, Gulf Oil Corporation, Philadelphia; and F. W. Sullivan, Jr., Standard Oil Company (Indiana), Chicago.

Loomis Heads Committee On Refinery Technology

N. E. LOOMIS, Standard Oil Development Company, New York, has been appointed chairman of the American Petroleum Institute's Central Committee on Refinery Technology for 1938 by W. S. S. Rodgers, The Texas Company, New York, Institute vice president for refining. R. P. Anderson, secretary of the Institute's Division of Refining, will act as secretary of the committee. Members of the committee are:

H. W. Camp, Cities Service Oil Company, Tulsa; T. G. Delbridge, The Atlantic Refining Company, Philadelphia; B. C. Frichot, Deep Rock Oil Corporation, Cushing, Oklahoma; R. A. Halloran, Standard Oil Company of California, San Francisco; R. E. Haylett, Union Oil Company, Los Angeles; E. W. Isom, Sinclair Refining Company, New York; Emby Kaye, Skelly Oil Company, Tulsa; E. A. Lacomble, Shell Petroleum Corporation, St. Louis; K. G. Mackenzie, The Texas Company, New York; and E. B. McConnell, The Standard Oil Company (Ohio), Cleveland.

Also J. T. McCoy, Tide Water Associated Oil Company, Bayonne; F. W. McCurry, The Derby Oil Company, Wichita, Kansas; Walter Miller, Continental Oil Company, Ponca City; R. C. Osterstrom, The Pure Oil Company, Chicago; A. E. Pew, Jr., Sun Oil Company, Philadelphia; J. B. Rather, Socony-Vacuum Oil Company, New York; W. F. Sims, Panhandle Refining Company, Wichita Falls, Texas; Herschel G. Smith, Gulf Oil Corporation, Philadelphia; Bruce K. Brown, Standard Oil Company (Indiana), Chicago; H. D. Wilde, Humble Oil & Refining Company, Houston; and M. P. Youker, Phillips Petroleum Company, Bartlesville.

Refineries' Accident Prevention Committee Named

GLENN BYERS, Shell Petroleum Corporation, St. Louis, will serve as 1938 chairman of the American Petroleum Institute's Committee on Accident Prevention in Refineries. The appointment was made by N. E. Loomis, chairman of the Central Committee on Refinery Technology. H. N. Blakeslee, director of the Institute's Department of Accident Prevention, was named secretary of the committee. Members of the committee are:

J. C. Bernd, Sinclair Refining Company, East Chicago, Ind.; R. W. Black, Standard Oil Company of New Jersey, Elizabeth, N. J.; J. S. Boylan, Continental Oil Company, Ponca City, Oklahoma; J. H. Brown, Tide Water Associated Oil Company, New York; C. W. Coleman, Gulf Oil Corporation, Port Arthur, Texas; R. E. Donovan, Standard Oil Company of California, San Francisco; J. H. Herbert, Socony-Vacuum Oil Company (White Star Division), Detroit, Mich.; D. B. Hiatt, Texas Pacific Coal & Oil Company, Fort Worth; J. Howard Myers, The Atlantic Refining Company, Philadelphia; and L. F. Knox, General Petroleum Corporation, Los Angeles.

Also O. B. Lewis, Ethyl Gasoline Corporation, New York; W. F. Lowe, Natural Gasoline Association of America, Tulsa; A. A. Nichoson, The Texas Company, New York; C. J. Nobmann, Shell Oil Company, San Francisco; A. A. Odell, Barnsdall Refineries, Inc., Tulsa; G. F. Prussing, Union Oil Company, Los Angeles; W. P. Reymond, Jr., Standard Oil Company of Louisiana, Baton Rouge, Louisiana; S. D. Saltonstall, Lion Oil Refining Company, El Dorado, Arkansas; C. W. Smith, Standard Oil Company (Indiana), Chicago; C. L. Swim, Skelly Oil Company, Tulsa; and M. P. Youker, Phillips Petroleum Company, Bartlesville, Oklahoma.

TRANSMISSION of and CONTROL . . .

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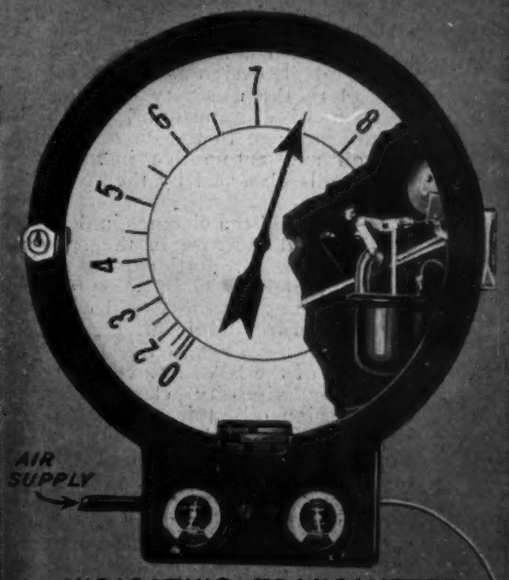
The Receiver, a recording instrument, contains the Remote Receiving Unit . . . in effect, a simple pressure gauge, calibrated in units to agree with the transmitter scale. It may be controlling or non-controlling.

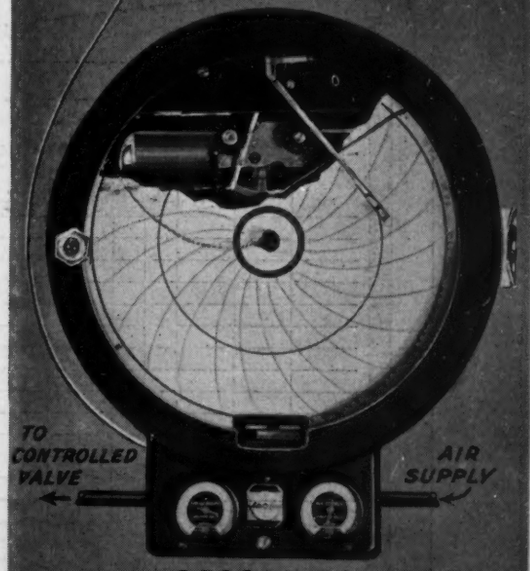
There is nothing complicated or delicate in the construction of the Brown Pneumatic Remote Transmission System.

When you install Brown Instruments you obtain the ultimate in process control—because there is no divided responsibility. Brown can give you the instrument best suited for your application, whether for indicating, recording or controlling—in either electric, pneumatic or combined electric and pneumatic systems.

At the International Petroleum Exposition, Booths 41 and 42, Scientific and Technical Bldg., see this Pneumatic Remote Transmission System in operation. Get full details . . . write for Bulletin No. 94-2. THE BROWN INSTRUMENT COMPANY, a division of Minneapolis-Honeywell Regulator Company, 4498 Wayne Avenue, Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter Street. Amsterdam-C, Holland: Wijdesteeg 4. London, England: 70 St. Thomas' Street, S. E. 1.



INDICATING TRANSMITTER



RECORDING CONTROLLING RECEIVER

BROWN PNEUMATIC . . . REMOTE TRANSMISSION SYSTEM

FOR TEMPERATURES • • • PRESSURES • • • FLOWS • • • LIQUID LEVELS

New S.A.E. Transmission And Rear Axle Lubricants

THE object of S.A.E. lubricant classification is to make it as easy as possible to select the most suitable viscosity for the conditions of use. Changes in automobile design and usage naturally lead to the necessity of occasional revision of classifications, which led some years ago to the introduction by the oil and automotive industries of winter oils classified by their viscosity at 0°F.

There have been changes in design of gearing, and increase in the speed of transmissions proportional to the increase in engine speeds, to say nothing of the coming into this field of highly special types of lubricant. Therefore, a little over a year ago the Lubricants Division of the S.A.E. moved to reconsider the viscosity classification of transmission oils, this resulting in the issuance of an entirely new classification, which was approved by the Standards Committee of the society last January.

As appears in the copy of the classification below, the old requirement concerning channeling remains in the classification. There is, of course, no standard test for this characteristic. It means that lubricants must not channel in actual service at the specified temperatures.

The actual classification as it will appear in the 1938 S.A.E. Handbook reads as follows:

"The S.A.E. viscosity numbers for transmission and rear axle lubricants constitute a classification in terms of viscosity and of consistency at low temperatures only. Other factors of quality or character are not considered.

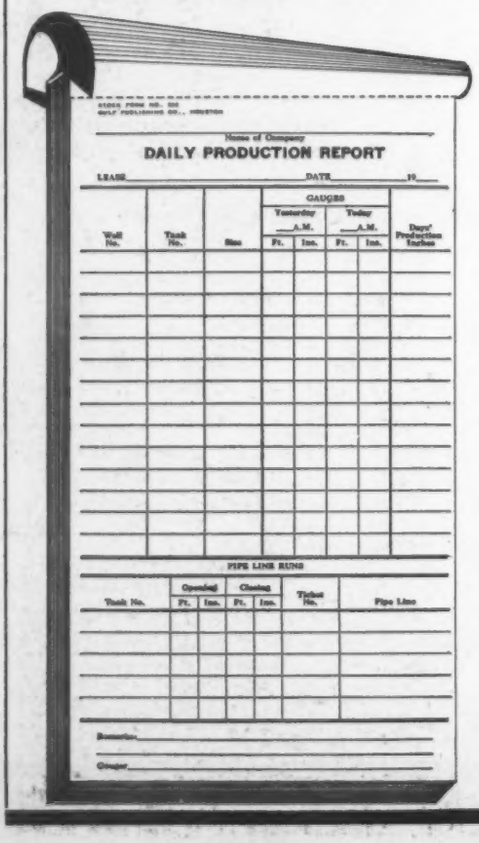
"The viscosity range and consistency at low temperatures for the several classes of transmission and rear axle lubricants are defined in the following table:

S.A.E. Viscosity Number	Viscosity Range Saybolt Universal	Consistency Must not channel in service at °F.
S.A.E. 80	100,000 seconds at 0°F. Max.	—20
S.A.E. 90	800 to 1500 seconds at 100°F.	0
S.A.E. 140	120 to 200 seconds at 210°F.	+35
S.A.E. 250	200 seconds at 210°F. Min.	—

"In the case of S.A.E. 80, the minimum viscosity limit is not specified since this grade is specially for use at very low temperatures at which S.A.E. 90 would be too heavy. The oil company furnishing the lubricant shall be responsible for maintaining a sufficiently high minimum viscosity to provide satisfactory lubrication. In a similar manner the maximum viscosity limit for S.A.E. 250 is not specified since this grade is a special one for temperatures at which S.A.E. 140 is too light. The oil company furnishing this lubricant shall be responsible for maintaining a sufficiently low maximum viscosity to provide satisfactory shifting of gears without channeling at the lowest temperature for which the lubricant is recommended.

"In the case of fluid greases made by adding soap or other thickening ingredients to oil, the viscosity number by which the lubricants are classified shall be determined by the viscosity of the oil before the addition of the soap or other thickening ingredients."

OIL COMPANY STOCK FORMS



for Accounting *and* Field Reporting

The GULF PUBLISHING COMPANY operates a department for the design and production of forms for oil company accounting and field reporting and carry in stock, ready for use, over 100 forms.

We have published a completely illustrated catalog of these forms. At your request we will send you a copy of this catalog.

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Bituminous Waterproofing And Roofing Materials

A. S. T. M. Committee D-8 has been extremely active during the past year, and as a result a number of recommendations were acted upon at the recent Rochester meeting which will be considered formally by letter ballot before submission to the Society at the annual meeting in June.

There were presented proposed specifications for asphalt mastic suitable for use in waterproofing which cover a material consisting of asphalt cement, mineral filler and mineral aggregate. The grade of asphalt mastic covered is suitable for waterproofing the floors of buildings and bridges, or reservoirs, waterways, subways, etc.

The work on membrane materials has been particularly active during the year, and a review of a number of the standards and tentative standards has resulted in revisions and modifications being presented in the following specifications:

The Standard Specifications for Asphalt-Saturated Roofing Felt for Use in Waterproofing and in Constructing Built-Up Roofs (D 226-27) will be revised to include 30 lb. material in order to bring this standard up to date. Revisions were also recommended in the Standard Specifications for Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Waterproofing (D 173-27) in order that they will be in agreement with present practice. The changes involve the inclusion of a provision for spraying the saturant in the manufacture of the saturated fabrics and also changes in certain of the physical properties including moisture, pliability tests and weight of saturant.

The committee recommended the withdrawal of the specifications for burlap saturated with bituminous substances (D 174-25) since the use of this material has been discontinued.

As a result of the changes in the pliability requirements for saturated felts and fabrics, a revision in the pliability test procedure was recommended for inclusion in the Standard Methods of Testing Felted and Woven Fabrics Saturated with Bituminous Substances for Use in Waterproofing and Roofing (D 146-37).

On behalf of Subcommittee X on Standard Coefficient of Expansion for Bituminous Products, W. H. Fulweiler, Consulting Chemist, presented a report calling attention to the fact that there appeared to be a lineal relation between the specific gravity and coefficient of expansion. He stated that the subcommittee will recommend for action at the June meeting the adoption of the following coefficients—following the practice of the work on petroleum products, there will be four classes of material:

Type of Material	Coefficient of Expansion
Creosote Oils	0.00040 per deg. F.
Primers	0.00035
Cements	0.00030
Pitches	0.00026

It was pointed out that these figures represent current practice by a number of states and the industry.

A report covering studies on the quantitative analysis of different types of fibers in roofing felt was presented, and it is planned to include the results of this study in the annual report of the committee.

DIFFICULTIES TRACEABLE TO *Salts* IN PETROLEUM

Refiners who are experiencing any of the difficulties enumerated above will find it extremely profitable to investigate the Petreco Electromatic De-Salting Process.

It has been definitely determined that salts in crude charging stocks are very often responsible for these problems. In many cases the Petreco process has solved them efficiently, economically and permanently.

Refiners throughout the country who are using Petreco Electromatic De-Salters are saving thousands of dollars every month by increasing onstream time, reducing repair and replacement costs, and improving the quality of asphalt and residual fuel oils.

Petreco Engineers are available to assist in determining the causes of your refining problems, and solving them if they are caused by salts. Consultations and preliminary investigations involve no cost or obligation.

PETROLEUM RECTIFYING COMPANY OF CALIFORNIA
General Offices: 530 West Sixth Street, Los Angeles, California
Branch Office: Houston, Texas. Branches and Service Men in Principal Oil Fields

Smith Heads A.P.I. Committee on Natural Gas

S. S. SMITH, Shell Petroleum Corporation, St. Louis, has been appointed chairman of the 1938 Group 1 Sub-committee on Natural Gasoline of the American Petroleum Institute's Central Committee on Measuring, Sampling and Testing Natural Gas and Natural Gasoline. The announcement was made by F. E. Rice, Phillips Petroleum Company, Bartlesville, chairman of the Central Committee, who also announced the following membership of Group 1 Sub-committee:

R. C. Alden, Phillips Petroleum Company, Bartlesville; H. R. Auerswald, Gulf Oil Corporation, Tulsa; C. L. Baker, The Texas Company, Tulsa; Paul M. Bowman, Amerada Petroleum Corporation, Seminole, Okla.; D. B. Dow, Indian Territory Illuminating Oil Company, Bartlesville; George E. Edgett, Carter Oil Company, Tulsa; C. D. Gard, Union Oil Company of California, Santa Fe Springs, Calif.; R. D. Hanley, Magnolia Petroleum Company, Dallas, Texas; Dean Hiatt, Texas Pacific Coal & Oil Company, Fort Worth; Walter Helmick, Shell Oil Company, Los Angeles; and J. R. Jarvis, Lone Star Gas Company, Dallas.

E. C. LeFevre, Cities Service Oil Company, Bartlesville; P. S. Magruder, General Petroleum Corporation, Los Angeles; Roy O. Neal, Neal Gasoline Company, Tulsa; A. T. Scherer, Sinclair Prairie Oil Company, Tulsa; A. J. Schlosser, Barnsdall Oil Company, Tulsa; F. M. Seibert, Gulf Oil Corporation, Houston; J. B. Taylor, Signal Oil & Gas Company, Los Angeles; J. W. Vaiden, Skelly Oil Company, Tulsa; C. E. Webber, Humble Oil & Refining Company, Houston; D. M. Wolfe, Standard Gasoline Company, San Francisco; and William Young, The Texas Company, Los Angeles.

Sub-committee 1-A—Tank and Temperature Measurement: Chairman, H. R. Auerswald, Gulf Oil Corporation, Tulsa; C. L. Baker, The Texas Company, Tulsa; George E. Edgett, Carter Oil Company, Tulsa; P. S. Magruder, General Petroleum Corporation, Los Angeles; Roy O. Neal, Neal Gasoline Company, Tulsa; A. J. Schlosser. Barnsdall Oil Company, Tulsa, and J. W. Vaiden, Skelly Oil Company, Tulsa.

Sub-committee 1-B—Measurement by Meter: Chairman, P. S. Magruder, General Petroleum Corporation, Los Angeles; The California Natural Gas Association will act as Magruder's committee.

Sub-committee 1-C—Sampling: Chairman, R. D. Hanley, Magnolia Petroleum Company, Dallas; Dean Hiatt, Texas Pacific Coal & Oil Company, Fort Worth; J. R. Jarvis, Lone Star Gas Company, Dallas; and P. S. Magruder, General Petroleum Corporation, Los Angeles.

Sub-committee 1-D—Testing: Chairman, R. C. Alden, Phillips Petroleum Company; D. B. Dow, Indian Territory Illuminating Oil Company; and E. C. LeFevre, Cities Service Oil Company, all of Bartlesville, Oklahoma.

Western Refiners Reelect all Officers

THE Western Petroleum Refiners Association at its twenty-sixth annual meeting held in Hot Springs, Arkansas, this week, reelected its officers for the 1938-1939 period.

C. M. BOGGS
Re-elected President of the Western Refiners Association.

C. M. Boggs, Kanotex Refining Company, Arkansas City, Kansas, was reelected president of the association. Also, reelected were H. T. Ashton, Lubrite Division, Socony - Vacuum Oil Company, St. Louis, as executive vice president; Roy B. Jones, Panhandle Refining Company, Wichita Falls; R. W. McDowell, Mid-Continent Petroleum Corporation, Tulsa, and T. M. Martin, Lion Oil Refining Company, El Dorado, Arkansas, vice presidents. A. V. Bourque continues with the association as secretary and treasurer. All of the board of directors, representing the majority of the refining companies in the Mid-Continent area, were reelected.

E. M. Smith Heads Electrical Association

THE Petroleum Industry Electrical Association, meeting at the Rice Hotel, Houston, April 12, 13, 14, 15 and with attendance of about 200, elected E. M. Smith of The United Gas Pipe Line Company, Houston, president to succeed P. F. Davis of The Texas Pipe Line Company, Tulsa, who served during the past year. The association elected D. W. Sims of Continental Pipe Line Company, Ponca City, vice president and re-elected H. E. Browne of Sinclair Prairie Pipe Line Company, Independence, Kansas, as secretary and treasurer.

The convention was welcomed Tuesday morning by W. N. Blanton of the Houston Chamber of Commerce, with response by E. M. Smith, new president of the association. One session Tuesday was given over to the study and discussion of safety problems in conjunction with the operation and maintenance of electrical equipment and this session was led by R. B. Roaper of Humble Pipe Line Company, Houston. Rural electrification discussion was led by J. F. Collerain, Houston Pipe Line Company, Houston, and New Equipment and Its Application, another open discussion was led by L. E. Adler of Magnolia Pipe Line Company, Dallas.

Hezzie Clark, Humble Pipe Line Company, Houston, presented a paper on "Telegraph Carriers," and "Some Engineering Considerations in the Use of Telephone Repeater and Carrier Systems" was the subject of a paper by J. A. Parrott, American Telephone and Telegraph Company, New York. One session was devoted to cathodic protection of pipe lines at which time W. B. Poor, United Gas Pipe Line Company, Houston, presented a paper on "Electrical Protection, Methods, Results and Application," which was followed by discussion of various phases of this development. The annual banquet was held in the Rice Hotel Thursday, at which time the convention was addressed by W. L. Childs of Reed Roller Bit Company, and president of the Houston Chamber of Commerce. Held in conjunction with the convention sessions was an exhibition of latest types of electrical equipments in which 38 manufacturing concerns participated.

Next year's meeting will be in Houston.

Mackenzie Heads Institute Testing Methods Committee

K. G. Mackenzie, The Texas Company, New York, will serve as 1938 chairman of the American Petroleum Institute's Committee on Testing Methods and Specifications. Appointment was made by N. E. Loomis, chairman of the Central Committee on Refinery Technology, who announced that R. P. Anderson, secretary of the Institute's Division of Refining, would be secretary. The committee membership follows:

H. T. Bennett, Mid-Continent Petroleum Corporation, Tulsa; J. T-B. Bowles, Crown Central Petroleum Corporation, Baltimore; F. W. Breth, L. Sonneborn Sons, Inc., Petrolia, Pa.; H. W. Camp, Cities Service Oil Company, Tulsa; R. O. Campbell, The British American Refineries, Ltd., Toronto, Canada; S. E. Campbell, MacMillan Petroleum Corporation, Long Beach, Calif.; B. R. Carney, Shell Union Oil Corporation, New York; E. W. Dean, Standard Oil Development Company, New York; T. G. Delbridge, The Atlantic Refining Company, Philadelphia; B. C. Frichot, Deep Rock Oil Corporation, Cushing, Okla.; and F. L. Garton, Shell Petroleum Corporation, Wood River, Illinois.

Also C. K. Hewes, Richfield Oil Company, Wilmington, Calif.; J. Bennett Hill, Sun Oil Company, Marcus Hook, Pa.; E. M. Keely, Cities Service Oil Company, Philadelphia; R. E. Luton, Lincoln Oil Refining Company, Robinson, Ill.; A. G. Marshall, Shell Oil Company, Martinez, Calif.; Ralph R. Matthews, Battenfeld Grease & Oil

Corporation, Kansas City; E. B. McConnell, The Standard Oil Company (Ohio), Cleveland; J. T. McCoy, Tide Water Associated Oil Company, Bayonne; Gordon McIntyre, Imperial Oil Refineries, Sarnia, Ontario, Canada; D. R. Merrill, Union Oil Company, Wilmington, Calif.; A. E. Miller, Sinclair Refining Company, New York; and L. L. Davis, Continental Oil Company, Ponca City.

Also L. Mittelman, Tide Water Associated Oil Company, Associated, Calif.; G. G. Oberfell, Phillips Petroleum Company, Bartlesville; R. C. Osterstrom, The Pure Oil Company, Chicago; H. B. Pullar, Berry Asphalt Company, Chicago; J. B. Rather, Socony-Vacuum Oil Company, New York; T. H. Rogers, Standard Oil Company, (Indiana), Whiting, Ind.; Herschel G. Smith, Gulf Oil Corporation, Philadelphia; G. R. Taylor, McColl-Frontenac Oil Company, Montreal, Canada; J. B. Terry, Standard Oil Company of California, San Francisco; E. R. Wiles, Barnsdall Refining Corporation, Barnsdall, Okla.; and W. S. Zehrung, The Pennzoil Company, Oil City, Pa.

A.S.T.M. Has Committee On Radiographic Testing

SINCE the Symposium on Radiography and X-ray Diffraction Methods sponsored by the American Society for Testing Materials in 1936, there has been evident an increasing interest in the need for research and standardization work on important problems in the field of radiographic testing. In order to carry out work in this field the Society has organized a new committee designated E-7 on Radiographic Testing. The new committee will extend phases of the work heretofore carried out by Committee E-4 on Metallography. Under the leadership of Dr. H. H. Lester, Watertown Arsenal, who was asked to take charge of developing preliminary plans for the committee, the committee was formally organized on February 14 at a meeting held in New York City, at which a large number of those invited to serve on the committee were present. There was also a meeting held during A. S. T. M. Committee Week in Rochester.

The general scope of the committee work is indicated by the subcommittees which are in course of formation. The committee expects to develop a formal statement of scope in the near future. At both the New York and the Rochester meetings it was emphasized that the committee should work with similar groups in other societies and that aim should be to cooperate, to correlate, but not to duplicate. In order to cooperate to best advantage, other radiographic committees are represented in the membership of Committee E-7.

The six subcommittees which are being appointed, together with the chairmen who will direct their work are indicated in the following list:

Subcommittee I on Radiography of Cast Metal—C . W. Briggs, American Foundrymen's Assn.

Subcommittee II on Technical Research—H. E. Seemann, Eastman Kodak Co.

Subcommittee III on Radiography of Welds and Weldments—H. H. Lester (temporary chairman), Watertown Arsenal.

Subcommittee IV on Correlated Abstracts—W. P. Davey, Pennsylvania State College.

Subcommittee V on Safety—E. W. Page, General Electric X-ray Corp.

Subcommittee VI on Programs—Lars Thomassen, University of Michigan.

In addition to these subgroups, in view of the importance of starting work immediately on radiographic inspection of certain special products such as valves and fittings where castings, forgings and similar parts are welded, it was decided to organize a section of Subcommittee III to work in cooperation with Subcommittee I.

It has been decided to hold another meeting of the committee in June during the A. S. T. M. Annual Meeting in Atlantic City. At this meeting reports are to be presented by the Subcommittees on Correlated Abstracts and on Program. One of the main features of the meeting is to be a technical session at which there will be several papers presented on radiographic activities of direct interest to the work of the committee.

Committee Personnel

A number of outstanding authorities in the radiographic field were invited to become members of this new committee. The present personnel is as follows:

C. A. Adams, Edward G. Budd Manufacturing Co.

American Brake Shoe and Foundry Co., Earnshaw Cook.

American Chain and Cable Co., Inc., L. C. Wilson.

American Foundrymen's Assn., C. W. Briggs.

American Steel Foundries, W. C. Hamilton.

The Babcock & Wilcox Co., J. C. Hodge.

Bell Telephone Laboratories, Inc., L. E. Abbott.

The Bonney-Floyd Company, R. H. Frank.

Combustion Engineering Co., Inc., Hedges-Walsh-Weidner Div., E. C. Chapman.

J. J. Curran, Walworth Co.

P. D. Field, Bethlehem Shipbuilding Corp., Ltd.

Ford Motor Co., D. M. McCutcheon.

General Alloys Co., G. C. McCormick.

General Electric Co., W. G. Conant.

Gulf Research and Development Co., B. B. Wescott.

Victor Hicks, Westinghouse X-ray Co.

H. R. Isenburger, St. John X-ray Service, Inc.

G. F. Jenks, U. S. Army, Ordnance Dept.

The W. M. Kellogg Co., A. Kidd.

Lebanon Steel Foundry, Fred Grotts.

H. H. Lester, Watertown Arsenal.

J. P. Magos, Crane Co.

V. T. Malcolm, Chapman Valve Manufacturing Co.

Maryland Casualty Co., A. G. L. Barkow.

P. E. McKinney, Bethlehem Steel Co., Inc.

N. L. Mochel, Westinghouse Electric and Manufacturing Co.

J. T. Norton, Massachusetts Institute of Technology.

The Ohio Steel Foundry Co., E. H. Mebs.

E. W. Page, General Electric X-ray Corp.

Lucius Pitkin, Inc., Alexander Gobus.

H. E. Seemann, Eastman Kodak Co.

Shell Petroleum Corp., G. C. Dick.

A. O. Smith Corp., C. W. Wheatley.

Standard Oil Development Co., F. C. Fyke.

Steel Founder's Society of America, J. H. Hall.

Lars Thomassen, University of Michigan.

Union Carbide and Carbon Research Laboratories, Inc., C. O. Burgess.

U. S. Navy, Bureau of Engineering, Specifications Section, Design Division.

K. R. Van Horn, Aluminum Company of America.

Consulting Members

W. P. Davey, Pennsylvania State College.

G. E. Doan, Lehigh University.

R. A. Gezelius, Taylor-Wharton Iron and Steel Co.

N. A. Kahn, U. S. Navy Yard, Brooklyn.

The personnel of the several subcommittees which are being organized will be made up of members of the main committee.

Doctor Lester has been elected permanent chairman of the new committee and Earnshaw Cook, American Brake Shoe and Foundry Company, was chosen as the secretary.

Refinery Waste Disposal In Second Edition

THE SECOND edition of Section 11, of the booklet "Disposal of Refinery Wastes" has been published by the American Petroleum Institute, Division of Refining, following preparation by the divisional committee and approval by the general committee. The section presents in convenient form information designed to promote the adoption of approved principles and practices for disposing of poisonous, irritant and malodorous wastes and refinery aerosols.

Sullivan Named Member A.P.I. Refinery Committee

D. E. SULLIVAN, chief engineer, The Pure Oil Company, Chicago, has been appointed a member of the Committee on Disposal of Refinery Wastes of the American Petroleum Institute's Division of Refining. Announcement of the appointment was made by N. E. Loomis, chairman of the Institute's Central Committee on Refinery Technology.

Davis Named Chairman of Equipment Corrosion

L. L. DAVIS, Continent Oil Company, Ponca City, has been named chairman of the American Petroleum Institute's 1938 Committee on Corrosion of Refinery Equipment by N. E. Loomis, chairman of the Central Committee on Refinery Technology. D. V. Stroop, engineer on the Institute's staff, will act as secretary. Members of the committee are:

C. C. Ashley, Shell Oil Company, San Francisco; A. B. Bagsar, Sun Oil

Company, Marcus Hook, Pennsylvania; . B. Bluhm, Sinclair Refining Company, East Chicago, Ind.; F. C. Braun, Gulf Oil Corporation, Pittsburgh; E. S. Dixon, The Texas Company, Port Arthur; R. L. Duff, Standard Oil Development Company, Elizabeth, N. J.; L. M. Goldsmith, The Atlantic Refining Company, Philadelphia; and J. W. Griswold, Cities Service Oil Company, New York.

Also A. E. Harnsberger, The Pure Oil Company, Chicago; W. R. Hicks, Humble Oil & Refining Company, Baytown, Texas; K. V. King, Standard Oil Company of Calif., San Francisco; J. T. McCoy, Tide Water Associated Oil Company, Bayonne; L. G. Metcalf, Union Oil Company, Los Angeles; J. W. Newton, Magnolia Petroleum Company, Beaumont, Texas; Joseph K. Roberts, Standard Oil Company (Indiana), Whiting, Ind.; and M. P. Youker, Phillips Petroleum Company, Bartlesville.

Refiners Protest Insurance Rates

MORE refiners are joining the fight to reduce unfair fire insurance rates on cracking units for refiners who avail themselves of independent technical inspection service. Such inspection, it has been proved over a term of years, makes cracking stills a superior risk.

The records show that over a period of 8 years the ratio of losses paid to premiums collected on independently-inspected cracking units has been 15 percent, whereas the normal average loss ratio on all classes of property is 50 percent.

In other words, the insurance companies have collected a dollar from such refiners for every 15 cents they have paid in losses.

A committee of Texas refiners headed by Roy B. Jones, president of Panhandle Refining Company, Wichita Falls, has presented a strong protest against unfair rates to the Texas Fire Insurance Commission.

Other members of the Texas committee are: W. D. Richardson, Cosden Oil Corporation, Fort Worth; Ray Woolf, Shamrock Oil & Gas Corporation, Amarillo; Ben B. Piepgrass, Solvex Refineries, Gladewater; J. F. Lucey, Talco Asphalt & Refining Company, Mount Pleasant, R. E. Hall, McMurray Petroleum Corporation, Tyler, and J. D. Bright, Waggoner Refining Company, Vernon.

A committee of Oklahoma refiners has also been formed, with Albert Finston, president of Bell Oil & Gas Company, as chairman, to present the matter to the State Insurance Board. Committees are rapidly being organized in other states.

The unfairness of the rates charged for cracking stills which are inspected by an independent technical agency is apparent, the refiners point out, when it is considered that the expense is borne entirely by the refiners, whereas, in the case of steam boilers the insurance companies spend from 45 to 55 cents of every premium dollar for inspection service.

This fight for fair insurance rates on cracking stills started three years ago when several Dubbs licensees, because of their own favorable fire loss experience, attributed to independent technical inspection service, which cost the insurance companies nothing, urged Universal to investigate the effect of independent technical inspection service on fire loss.

This was done, and Universal presented a complete appeal, based on the data collected, to the Fire Insurance Executives Association, with no result.

The dissatisfied refiners have now taken the matter in their own hands and are aggressively presenting their claims to the insurance authorities in their respective states.

Practical Information On Motor Gasoline

INFORMATION regarding the characteristics of motor gasolines marketed in various cities in different sections of the United States is given in a report just issued by the Bureau of Mines, United States Department of the Interior. Data on distillation range, vapor pressure, octane rating, and other matters of great interest to manufacturers of gasoline and designers of automobile engines are given in the report.

Probably the general public has a greater interest in the fuel that goes into the engines of its automobiles and has less accurate knowledge of the material than of almost any other commodity in general use, states the author. A fact often overlooked is that the designer of automobiles and the manu-

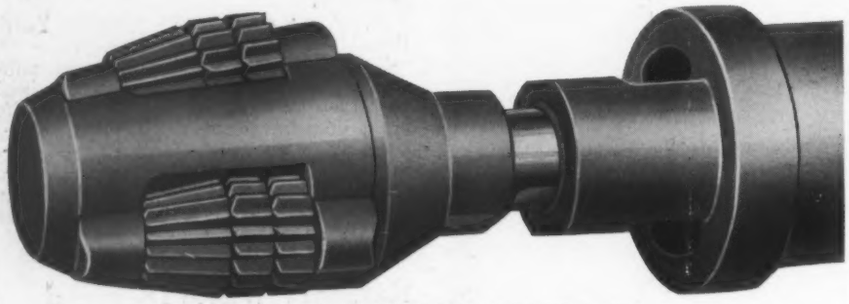

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FIG. 102
BRONZE GLOBE
VALVE.

FIG. 375
BRONZE GATE
VALVE.

FIG. 150
BRONZE GLOBE
VALVE.

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facturer of gasoline must know what kind of gasoline is being sold in all sections of the United States. The automobile designer needs this information so he can provide engines that will take full advantage of the characteristics that have been incorporated into the gasoline by the petroleum refiner. On the other hand, the individual petroleum refiner needs to know the characteristics of gasoline being made by all other refiners so he can make a product that will be within the limits of uniformity required for satisfactory engine operation.

For more than 20 years the Bureau of Mines has reported periodically on analyses of gasolines sold to the general public at service stations throughout the United States.

▼ PLANT ACTIVITIES ▼

Enlarge: Anglo-Canadian Oil Company, Brandon, Manitoba, Canada, has started operating the Central refinery of 1000 barrels capacity which it recently leased on a basis of $2500 annual rental. The company plans to increase capacity to 1800 barrels at once and to operate on Turner Valley crude shipped to the plant via tank car.

Gasoline Plant: Inglewood Gasoline Company, Los Angeles, is reported surveying the gas situation in the Wilmington field with the view to erecting a new natural gasoline plant in the old portion of the field where an estimated 12,000,000 cubic feet of gas is being produced daily.

Gasoline Plant: Sunray Oil Company and Phillips Petroleum Company, have started construction of a new natural gasoline plant in the K-M-A pool near Wichita Falls, Texas, costing about $500,000 as a joint venture and now control about 4000 acres of casing head gas contracts in that vicinity.

Alcohol: American Chemical Foundation, Atchison, Kansas, is reported planning a new plant at Sioux City, Iowa, for production of a new alcohol motor fuel to be used as a blend with gasoline. It will include power house, machine shop, tank department and other division to cost about $400,000.

Refinery: Lake Arthur Oil Refinery, Inc., Lake Arthur, Louisiana, is reported planning a new refinery in the Jennings oil field area to handle about 1100 barrels daily. Cost is reported at $70,000 and the company is reported affiliated with Imperial Oil Company, Houston.

Poly: Shell Petroleum Corporation is constructing polymerization units at its Houston and New Orleans refineries for conversion of by-product gas into high anti-knock gasoline. These units should be in operation by the middle of this year.

Repressuring: Portex Oil Company at Center, Shelby County, Texas, is constructing a gas repressuring plant and gasoline extraction unit with capacity of 100,000,000 cubic feet of gas a day. The plant being erected at reported cost of $150,000 is located 11 miles northeast of Center in the D. S. Haight survey. Gas will be taken from two of the company's gas-distillate wells completed recently, while the third well will be used for repressuring purposes. The company plans drilling 15 additional wells on its holdings in the area of present activity.

Topping: Maritime Oil Company, Houston, has let contract to Mid-Continent Engineering Company, Dallas, for construction of a 2000-barrel topping type refinery to be erected on the Houston Ship Channel. Southwest Texas crude will be brought in by tanker for processing into naphthas and various types of fuel oil distillates.

Refinery: Producers Refining Company, Shelby, Montana, recently organized, plans erection of a 3000-barrel refinery to process crude from the Pondera, Kelvin-Sunburst and Cut Bank fields.

Dismantling: General American Oil Company's three refineries at Gladewater, Arp and Overton, all of which have been shut down for some time, have been sold and are to be dismantled.

Purchase: Standard Oil Company (N. J.) has purchased 5½ acres of land adjacent to its Bayonne refinery, from Tide Water Associated Oil Company in what is known as the old Constable Hook area. The land was purchased for the purpose of providing room for

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Where ventilation is important Kerlow Grating does a real job—it permits the passage of light, heat, and air, and yet contains all the attributes of a solid, non-slip floor. The installation of Kerlow Gratings and Safety Steps is very simple and inexpensive.

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Please make a suggested layout of National Condensing and Cooling Sections, without obligation to us, to meet the following specifications:

1. Gravity of oil, °A.P.I.....
2. Quantity of vapor to be condensed, gals./hr.....
3. Quantity of liquid (in addition to vapor), gals/hr.....
4. Quantity of steam, lbs./hr.....
5. Quantity of non-condensable vapors, cu. ft./hr.....
6. Initial temperature of fluids, °F.....
7. Final temperature of fluids, °F.....
9. Final temperature of cooling water, °F.....
8. Initial temperature of cooling water, °F.....
10. Operating pressure, lbs./sq. in.....
11. Maximum allowable pressure drop, lbs/sq. in.....
12. Are Sections to be submerged ☐ or sprayed ☐
13. Available box size, if any.....long.....wide.....deep
14. Quantity of surface now used, if any, sq. ft.....
15. Nearest freight station.....

Name of individual.....

Name of company.....

Address.....

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immediate and future expansion of refining facilities.

Refinery: Inland Empire Refineries, Inc., Spokane, Washington, is erecting a 2500-barrel capacity plant under the supervision of Emby Kaye, recently resigned from Skelly Oil Company, Tulsa. The plant will be completed in July. Kaye is general manager of the Inland concern and of the affiliated newly formed Idaho Refining Company, which is building a 1500-barrel plant at Pocatello, Idaho. These two companies have the same stock ownership as the Wasatch Oil Refining Company of Salt Lake City, Utah, but will be under separate management.

Refinery: Yale Oil & Refining Company, Kalispell, Montana, is building a 1500-barrel refinery and expects to have it in operation within the next 60 days.

Refinery: Havre Oil & Refining Company, Kalispell, Montana, is erecting a 100-barrel skimming plant and this company has taken over the Aronow Refinery at Kalispell which is also a small skimming plant.

Modernize: Globe Oil & Refining Company, Lemont, Illinois, has let contract for construction and rehabilitation of its 16,000-barrel capacity refinery whereby larger yields of heating oils will be secured. Work will require about four months for completion.

Reorganize: Bryson Pipe Line & Refining Company, with headquarters in Wichita Falls, Texas, has been organized to take over Kraco Refining Company at Bryson, Texas. The company operates a 1500-barrel plant at Bryson and pipe line gathering system in the Bryson field.

Reforming Unit: Root Refining Company, El Dorado, Arkansas, is completing plans for the construction of a new reforming unit for production of higher-octane rating gasoline. The plant has been operating on Shuler crude for the past several months, in addition to Smackover and local crudes.

Gasoline Plant: Del Rey Producing Company, Houston, Texas, has started construction of a natural gasoline plant in the Sandy Point field, Brazoria County, Texas, to process 20,000,000 feet of gas a day.

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POSITIVE-displacement oil meters can be used to measure crude oil flowing in pipes in the field, and elsewhere, provided the counting mechanism is in proper adjustment and the oil has been studied sufficiently to determine the proper correction factor to be applied to the meter reading to adjust for the shrinkage of oil caused by the liberation of gas from solution, states the Bureau of Mines, United States Department of the Interior, which has completed a study on oil-meter calibration. A report giving the results of this study was made public at the Oil-Metering Conference, Norman, Okla., April 7.

Two different types of calibration tests were made. The first was a direct calibration to determine the accuracy of four different meters, through which measured quantities of weathered oil were pumped at different rates of throughput. The second type of test was made to determine the magnitude of error when metering a gas-saturated oil in which a pressure drop was induced upstream from the meter purposely to cause liberation of gas from solution in the oil in order to study the probable error under those conditions. The gas-saturated oil was obtained from a flowing well in the Oklahoma City field. The operating pressure in the separator was held between 80 and 83 pounds per square inch gage.

In connection with the meter-calibration study with gas-saturated oil, a sample of the oil was taken from the oil-gas separator under the same operating conditions as was the oil used for the meter tests. The oil sample was broken down in the laboratory into its proportionate parts of gas and oil at lower pressures. The quantity of gas liberated from solution and the shrinkage of the oil due to the liberation of gas were determined for each pressure reduction between the operating pressure of the separator and atmospheric pressure.

The results of the meter tests with gas-saturated oil in which pressure drops occurred upstream from the meter showed that the error in volume measurements by the meter was large.

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by

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Traver Road, Ann Arbor, Mich.

under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical and Chemical Data

Thermodynamic Properties of Hydrocarbons, W. C. EDMISTER, *Ind. & Eng. Chem.* **30** (1938), pp. 352-8.

Thermodynamic properties, such as deviation from the perfect gas laws, fugacities, specific heats, heats of vaporization, entropies, internal energies, free energies, and enthalpies or heat contents for petroleum hydrocarbons and their mixtures are of practical importance in engineering work associated with petroleum refinery operations. The preparation of tables or charts of these properties is complicated by the multiplicity of the petroleum hydrocarbons and by the scarcity of reliable, experimental specific heat and Joule-Thomson effect data. However, more P-V-T data are available, and consequently the effect of pressure on the above thermodynamic properties can be computed by means of the first and second laws of thermodynamics. As the result of previous work it became apparent that the most expeditious method of preparing tables and charts of thermodynamic properties for all of the normal paraffinic, isoparaffinic, olefinic, naphthenic, and aromatic hydrocarbons was a generalized method, by which these computations could be made once for all single-component hydrocarbon systems—in other words, a method that would result in "reduced" thermodynamic properties, which would be functions of reduced pressure and temperature. With such a method the tedious graphical differentiations and integrations could be performed with great care once to obtain the reduced thermodynamic properties; then by means of the critical constants for any given hydrocarbon it would be possible to compute the value of any desired thermodynamic property. A direct method of this nature is made possible by the graphical reduced equation of state developed and discussed by the author. This is based on a new correlation of P-V-T data. The effect of temperature on these thermodynamic properties can be computed by a new equation for specific heat at one atmosphere, which is based on a correlation of the data of Beeck, of Eucken and Lude, and of Eucken and Parts. By means of a table of generalized thermodynamic properties and equations presented in this paper, it is possible to compute all the thermal properties for any hydrocarbon for which critical data are available.

The Low-Temperature Heat Capacity of Gaseous Ethane, G. B. KISTIAKOWSKY AND F. NAZMI, *J. Chem. Phys.* **6** (1938), pp. 18-24.

The heat capacity of ethane was determined at 163° and 143° K by the hot-wire method. The curve does not flatten as was suggested by Eucken and Weigert. This is taken to indicate that ethane molecules do not possess free internal rotation.

Line Coordinate Chart for Vapor Pressures of Organic Solvents, D. S. DAVIS, *Ind. & Eng. Chem.* **30** (1938), pp. 320-1.

The author presents a line coordinate chart for the vapor pressures of 11 high-boiling organic solvents. The basis of the chart is the data of Gardner and Brewer, but these have been checked with other data available in the literature.

Compressibility of Butane - Pentane Mixtures Below One Atmosphere, F. W. JESSEN AND J. H. LIGHTFOOT, *Ind. & Eng. Chem.* **30** (1938), pp. 312-14.

The compressibility, $(pv)_0/(pv)_{800}$, of n-butane-n-pentane mixtures at 30° C. has been determined. The compressibility of n-pentane at 30° C. was obtained for pressures up to 500 mm. of mercury. The compressibility of propane was determined at 0° and 50° C., and that of isobutane at 0° and 30° C. The variation of the compressibility coefficient of propane and isobutane with temperature was determined. It was shown that the additive rule for determining the compressibility of gas mixtures at low pressures holds for mixtures of butane and pentane and for gaseous hydrocarbon mixtures comparable to those ordinarily encountered in natural-gas pipe line operations and in the production of natural gasoline. Data secured in the work are presented in detail in tabular form.

Compressibility of Liquid Naphthalene, F. R. RUSSELL AND H. C. HOTTEL, *Ind. & Eng. Chem.* **30** (1938), pp. 343-5.

Density data for naphthalene were available only for atmospheric pressure. In the course of an investigation of the rate of polymerization of ethylene in molten naphthalene it became necessary to know the temperature-density relation of naphthalene at temperatures up to about 800° F. and pressures up to 400 atmospheres. Specific gravity vs. temperature data were taken at 3030 pounds and 5800 pounds per square inch. The apparatus used is described, and the results of the work are presented in tabular and graphical form.

The Influence of Temperature and Pressure on the Volume and Refractive Index of Benzene, R. E. GIBSON AND J. F. KINCAID, *Jour. Am. Chem. Soc.* **60** (1938), pp. 511-18.

The compressions of benzene were measured at pressures up to 1250 bars and at temperatures between 25° and 65° C. The compressions are well represented by the Tait equation, and the constant of this equation is independent of temperature. The temperature variation of the second constant B in the Tait equation has been studied. The results indicate that B is the difference between the a/v^2 and $RT/(v-b)$, the attractive and repulsive forces in the liquid. The change in the refractive index of benzene with pressure was measured. The results confirm the empirical value of the Eykman specific refraction formula, and show that the compressibility of benzene can be calculated from refractive index-pressure measurements almost as accurately as it can be measured directly.

Surface Tension of Benzene, S. VALENTINER, *Oel u. kohle* **13** (1937), p. 1259.

The surface tension of six benzines which were special cuts with initial boiling points ranging from 50° to 120° C., as well as that of benzol, were determined by the wire-loop method, using a torsion balance. The surface tension of the benzines was found to be approximately 20 dynes/cm. in every case. The values rose slightly with increase of boiling point of the fraction. The temperature coefficient was 0.011-0.012 per 1° C. The interfacial tensions against water showed no definite temperature relationship between 20° and 40° C. For benzine, the surface tension and interfacial tension at 20° C. were 28.9 and 33.8 dynes/cm., and at 40° C. 26.2 and 31.2 dynes/cm.

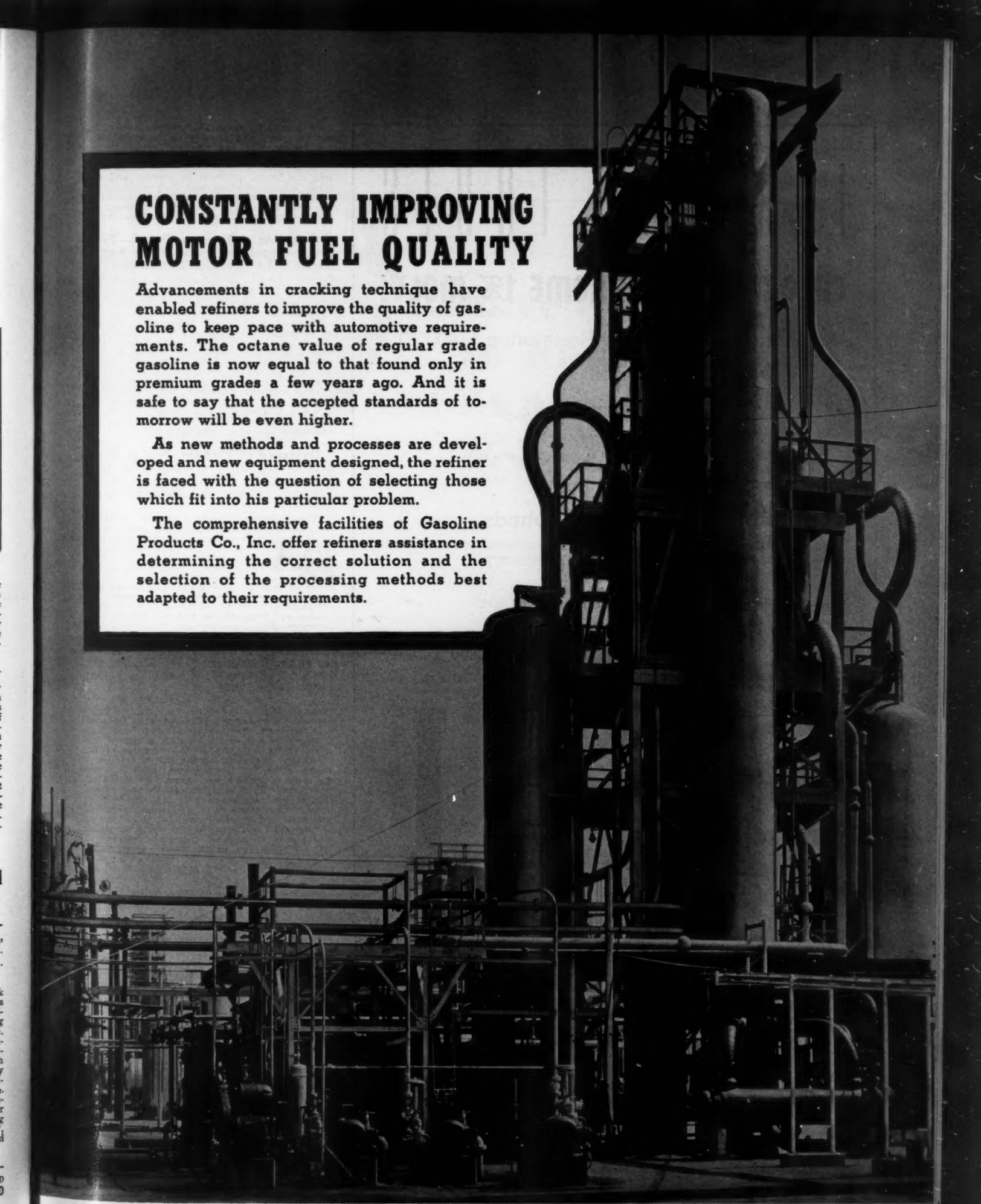
Chemical Compositions and Reactions

Separation of the Three Methyloctanes from Mid-Continent Petroleum, J. D. WHITE AND A. R. GLASGOW, JR., *J. Res. Natl. Bur. Standards* **19** (1937), pp. 423-35. (Research Paper No. 1033.)

The paper is a further report upon the work of separating an Oklahoma petroleum into its component hydrocarbons. 2-, 3-, and 4-methyloctane were isolated from the fraction distilling between 98° and 104° C. at 215 mm. pressure. Xylenes were first extracted with sulphur dioxide and the aromatic hydrocarbons were removed from the fraction by filtering through silica gel. The naphthenes were separated by distillation with glacial acetic acid. 2-methyloctane was crystallized from solution in CCl_2F_2. Further distillation, naphthene removal and crystallization permitted the separation of the other methyloctanes. The boiling points and freezing points reported were 143.255° and —80.49°, 144.180° and —108.00°, and 142.433° and —119.13° respectively.

Catalytic Hydration of Alkylacetylenes, R. J. THOMAS, K. N. CAMPBELL AND G. F. HENNION, *Jour. Am. Chem. Soc.* **60** (1938), pp. 718-20.

The authors note that surprisingly little work has been reported concerning the hydration of the alkylacetylenes to ketones. Such work as has



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4-6% Chrome 0.50% Molybdenum 1% Si	2900 lb	.....	.....
Calorized 1.50% Molybdenum	7200 lb	3350 lb	940 lb
2.25% Chrome 1% Molybdenum	6400 lb	2480 lb	960 lb

See article on these steels, page 179, April, 1937

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been done is reviewed. The catalytic method has not been applied previously to the hydration of the higher alkyl acetylenes. The compounds 1-hexyne, 1-heptyne and 1-octyne were selected for study. Solvents were used that would maintain the ketone products in solution and thus favor smooth reaction and high yield. Under conditions described the catalytic hydration of the three higher alkylacetylenes to ketones was accomplished readily and with excellent yields.

Oxidation of Propane, Part 1—Products of the Slow Oxidation at Atmospheric and at Reduced Pressures, D. M. NEWITT AND L. S. THORNES, *J. Chem. Soc.* **Oct.** (1937), pp. 1656-65.

A previously mixed mixture of propane and oxygen was rapidly admitted to a reaction vessel maintained at any chosen temperature. Progress of the reaction was followed by observation of the pressure, and by analysis of samples withdrawn at various stages. The first part of the paper describes the influence of pressure on the spontaneous ignition temperature of an equimolecular mixture. At atmospheric pressure the mixture will always ignite at 270° C. The region in which cool flames exist has been studied, and it was concluded that a necessary condition for cool-flame inflammation is a critical high concentration of higher aldehydes.

Oxidation of Propane, Part 2—Products of the Slow Oxidation at High Pressures, D. M. NEWITT AND W. G. SCHMIDT, *J. Chem. Soc.* **Oct.** (1937), pp. 1665-9.

When propane is oxidized at high pressures, isopropyl alcohol and acetone are found in the products, as it is believed that they arise from direct oxidation of the hydrocarbon molecule at the B-carbon atom. n-Propyl, ethyl, and methyl alcohols are also formed in considerable quantities, the yield of the higher alcohols being favored by increase of pressure. The results indicate that propane oxidized in two ways, the initial products in the one case being n-propyl alcohol and propaldehyde, and in the other case, isopropyl alcohol and acetone.

Oxidation of Propane, Part 3—Kinetics of the Oxidation, D. M. NEWITT AND L. S. THORNES, *J. Chem. Soc.*, **Oct.** (1937), pp. 1669-76.

The conditions under which the reaction of an equi-molecular propane-oxygen mixture has a negative temperature coefficient have been investigated, and the coefficients for the surface and homogeneous reactions were measured separately. The influence of the diameter of the vessel and of diluents on the rate of reaction is shown to be that which would result from the operation of a chain mechanism. The stages exerting controlling influences on the course and rate of the combustion are: (1) an initiating process that starts as a surface reaction and produces higher aldehydes, (2) a series of homogeneous reactions through which the higher aldehyde is reduced in a stepwise manner to formaldehyde, and (3) a reaction that occurs simultaneously with (2) and results in the aldehyde undergoing thermal decomposition.

Alkylation of Benzene with Cycloparaffins in the Presence of Sulfuric Acid, V. N. IPATIEFF, H. PINES AND B. B. CORSON, *Jour. Am. Chem. Soc.* **60** (1938), pp. 577-8.

Cyclopropane and methylcyclobutane alkylate benzene in the presence of cold 96% sulfuric acid to give n-propyl and t0amylbenzene, respectively. Cyclopentane does not alkylate benzene under the same experimental conditions.

The Selective Hydrogenation of Derivatives of Naphthalene and Diphenyl, D. M. MUSSER AND H. ADKINS, *Jour. Am. Chem. Soc.* **60** (1938), pp. 664-9.

The monohydroxynaphthalenes and diphenyls and their ethers have been submitted to partial hydrogenation over Raney nickel and copper-chromium oxide. The cost of the hydrogenation for a fairly large number of these compounds has been determined. Also, tetralin was made

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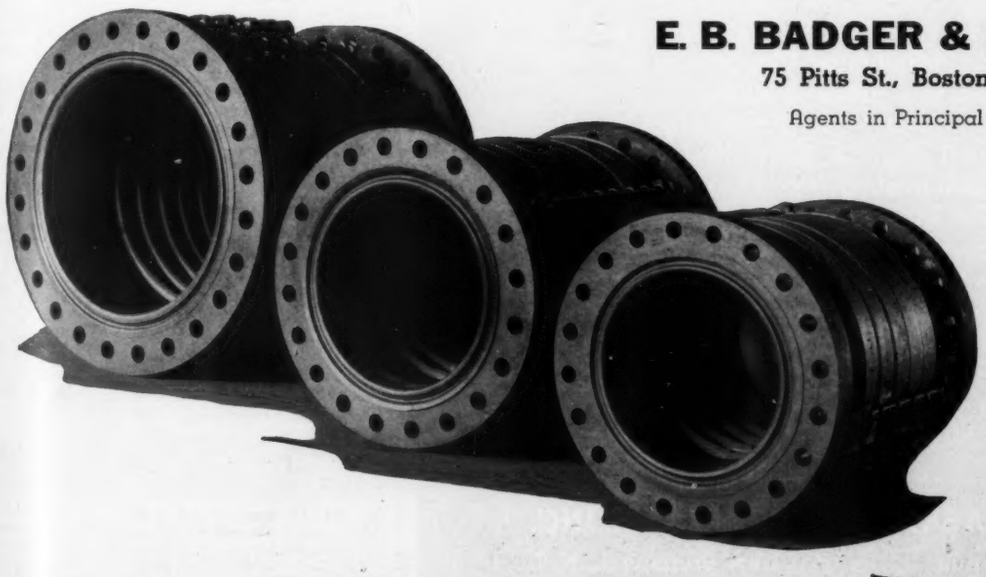

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for the first time over copper-chromium oxide. This catalyst has the advantage over Raney nickel that further hydrogenation does not occur at 200° C. Tetralin can, however, be made at 100° C., or lower by using Raney nickel as catalyst.

Manufacture: Processes and Plant

Dephlegmator Efficiency, H. A. Webber and G. L. Bridger, *Ind. & Eng. Chem.* **30** (1938), pp. 315-18.

The authors state that the value of a dephlegmator or partial condenser as a rectifying device is an unsettled problem. The rectification in a partial condenser can take place under widely varying conditions, and in most cases equilibrium conditions do not prevail, thus making the efficiency of the condenser much less than is predicted by theory. A graphical method of determining the efficiency of a dephlegmator is presented. This is to be used in conjunction with the McCable and Thiele method of determining the efficiency of a rectifying column. The method presented is general, and is independent of the actual mechanism of condensation taking place in the dephlegmator. It offers a convenient and simple means of testing and comparing different dephlegmators as to efficiency, and may be of value in designing more efficient partial condensers. Typical data are presented for a laboratory dephlegmator. The dephlegmator was found to be equivalent to about one-half a theoretical plate.

An Investigation Into the Cost of Oil Absorption Plant for Natural Gasoline Recovery at High Pressure and Low Temperature, A. H. Nissan, *Jour. Inst. Pet. Tech.* **24** (1938), pp. 69-111.

One of the most important methods for gasoline recovery from natural gas is the oil-absorption process. In this process the quantity of gasoline absorbed by the oil varies with the operating pressure and temperature. The author considers a concrete case assuming a reasonable composition for the initial gas and for the final product. A series of absorption plants operating under pressures from 1 to 6 atmospheres at a constant temperature of 30° C. have been designed. Thus operating conditions were investigated for varying pressures at constant temperature. Another series of absorption plants working under a constant pressure of 1 atmosphere but at temperatures varying from —10° C. to 30° C. were designed in order to study the effects of varying temperatures at constant pressure. Capital charges and operating costs were determined for each of these plants. From the information so obtained, a choice was made as to the most economical system. The conclusion is that a compression plant operating at four atmospheres pressure and 30° C. costs substantially the same sum of money as a plant operating at one atmosphere and 20° C. The operating cost of the plant operating at one atmosphere and 20° C. is slightly higher than that of the compression plant. However, all things considered, the author favors the plant operating at 20° C. and one atmosphere pressure. Design data and calculations are presented in great detail.

The Question of the Storage Stability of Motor Fuels, Anon., *Oel, Kohle, Erdol, Teer* **13** (1937), pp. 935-40.

Cracked or "aromatized" gasolines and synthetic motor fuels have limited storage stability on account of their contents of unsaturated hydrocarbons. A quick method of testing storage stability has been developed. One hundred cc. of the fuel is allowed to drop from a dropping funnel upon a weighed glass dish standing on a boiling water bath. The dropping is timed so that the liquid vaporizes immediately in a current of air. Any inert gas can be used in place of air. The dish is dried at 105° C. for 30 minutes and weighed.

Olefins and Conjugated Dienes from Gas Oil, H. Tropsch, C. L. Thomas, G. Egloff and J. C. Morrell, *Ind. & Eng. Chem.* **30** (1938), pp. 169-72.

Gas oil was cracked under conditions of high temperature and low pressure, as for example, 950°C. and 175 mm. absolute pressure, with a contact time of 0.05 seconds. Under these conditions gas oil yields useful products corresponding to 73 percent by weight of the charge. The weight percent of these particular products useful in chemical synthesis are: ethylene, 28.2 percent, propene, 19.7 percent; butadiene, 6.6 percent; butenes, 8.3 percent; pentadiene, 3.1 percent, and higher conjugated dienes, 7.2 percent based on the gas oil reacted. Also 10.8 percent of a gasoline of high antiknock value was produced. The yield of butadiene was found to be not greatly influenced by temperature

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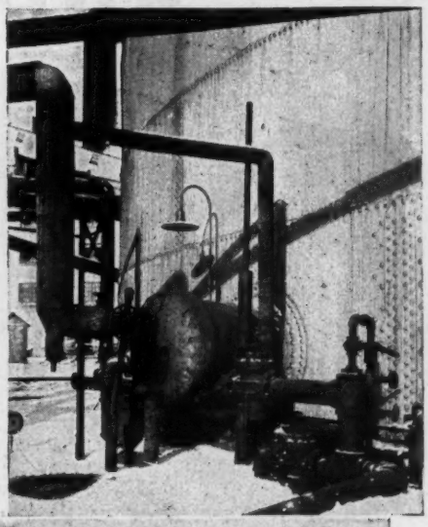

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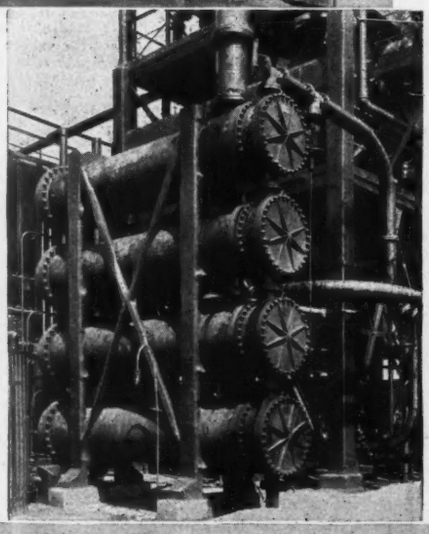

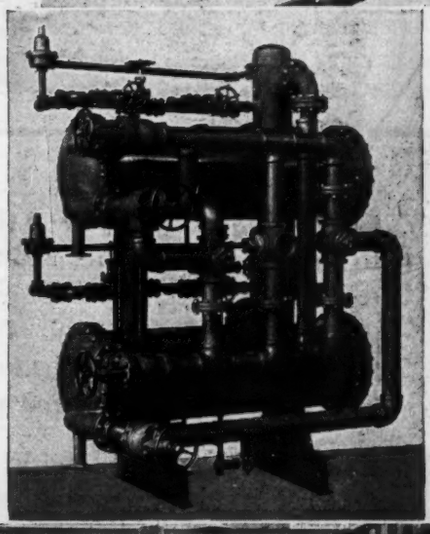

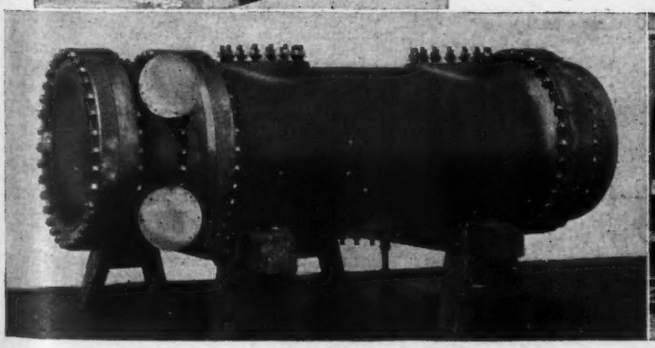

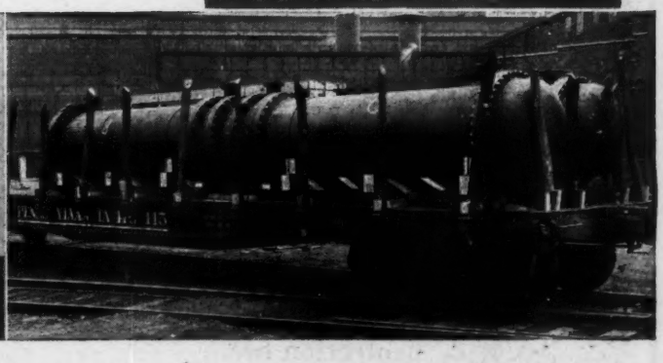

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over the range 800° to 1000°C. or pressure over the range 50 to 500 mms., provided the oil was gasified to the extent of 50 to 75% of the charge.

Studies on Crystallization of Paraffin Wax, R. FUSSTEIG, *Petroleum Times* **38** (1937), pp. 821-3.

The author believes that "amorphous" wax particles are surrounded by two films, the outer of resin-like nature, and the inner of viscous hydrocarbons. Removal of the outer film permits the growth of plate crystals. Removal of the second film reduces the surface tension sufficiently to allow crystallization in needles. For pressing, and particularly for sweating, a well-developed needle structure is desirable, so that the oil may run away from the cake freely. It has been found that a wax distillate containing plate-type wax will form needles if it is warmed and then quickly chilled by contact with cold water. A fractionating chiller using this principle has been developed. The warm stock is sprayed on the surface of cold water. Conventional solvent dewaxing gives a wax free filtrate, but a wax scale that crystallizes in plates. To obtain needles use can be made of the fractionating chiller with a mixture of solvents, e.g. 95 parts benzol and 5 parts phenol, in place of cold water. The warmed distillate is sprayed on the surface of the solvent. A highly concentrated needle structure is obtained amounting to 25 percent of the charge. The balance is a solution of oil in the solvent. Wax concentrates obtained by the use of this procedure both in the case of cold water and chilled solvents have given well-developed needle structures that are easily sweated to give a foots oil with a setting point below 0°C. It is claimed that improved yields of wax are obtained and that the method is simpler than the conventional procedures.

Electrical and Chemical Studies of Oil Oxidation, J. C. BALSBAUGH, R. G. LARSEN AND J. L. ONCLEY, *Ind. & Eng. Chem.* **30** (1938), pp. 287-93.

A summary of the effect of solvent refining on the physical, chemical and electrical properties of an oil is briefly given in tabular form. The results are indicative of the type of results that may be obtained by a study of a more extensive series of solvent-refined oils. They show that both extract and raffinate fractions should be studied, and that the properties of the original oil are usually intermediate between the two extreme fractions. Emphasis is placed on the design of equipment used in the studies, and the procedure for electrical tests.

Experiments on Pipe Coatings, C. FITZGERALD AND M. G. JOHNSON, *Ind. & Eng. Chem.* **30** (1938), pp. 294-6.

Among the many coating materials tested at Spindle Top Gully one has proved of particular promise. This is celluloid, or cellulose nitrate plastic. The celluloid was applied in two spiral wraps of transparent stock 5 mils thick and bonded to the pipe with an adhesive. After three years in a highly corrosive soil the results were so satisfactory that tests on an operating line appeared to be warranted. These tests are described. Another coating of some promise, although as yet in the early experimental stage, is pure rubber. Some of the preliminary results in the use of rubber are described.

Liquid-Level Control Apparatus, R. E. HERSH, E. M. FRY AND M. R. FENSKE, *Ind. & Eng. Chem.* **30** (1938), pp. 363-4.

Nearly all of the methods used for controlling liquid levels or liquid-liquid interface levels, depend on the use of floats at the surface or at the interface, or on a differential manometer mechanism. The authors describe simple and compact mechanisms for controlling interface levels or liquid levels. These devices operate on the differences in electrical conductivity of the two liquids at the interface, or of the liquid and air at the surface. Such a device for controlling the interface level in a lubricating oil extraction tower using a number of different solvents has been in satisfactory operation for more than a year. The apparatus consists essentially of electrodes at the interface and a means for utilizing the small current flowing through the solvent to operate a relay which, in turn, regulates the flow mechanism. Diagrams of the apparatus are given, as well as descriptive details.

Products: Properties and Utilization

Influence of Gaseous Electric Discharge on Hydrocarbon Oils, L. J. BERBERICH, *Ind. & Eng. Chem.* **30** (1938), pp. 280-6.

An investigation into the effect of gaseous

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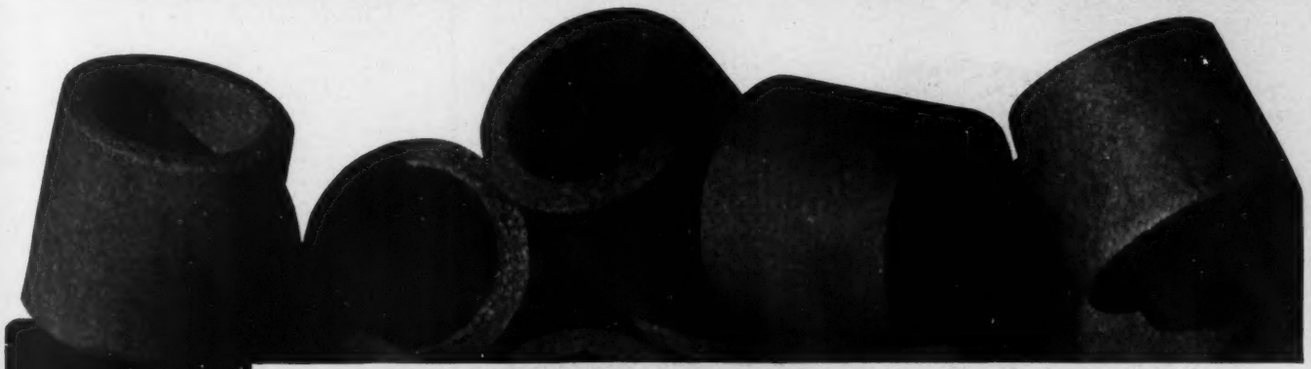

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Per Cent Free Gas Space.....	55	74	67	74	69	67	74	78

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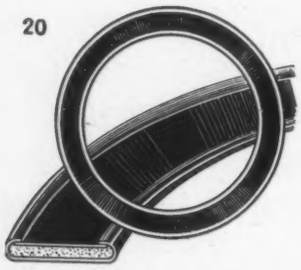

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electric discharge on insulation oils was begun several years ago. After confirming earlier work, a search was made for addition agents that would reduce the large gas evolution from paraffinic oils that normally possess high oxidative stability. It was found that when aromatic compounds were added to the oil the gas evolution was markedly reduced. Indirect evidence was obtained that hydrogenation of the addition compounds takes place. The vapor pressure of the compound, and the viscosity of the oil appear to influence the diffusion of the compound into the zone of reaction.

Melting Point Studies of Binary and Trinary Mixtures of Commercial Waxes, J. R. KOCH, G. J. HABLE AND L. WRANGELL, *Ind. & Eng. Chem., Anal. Ed.* **10** (1938), pp. 166-9.

A method is described for the determination of melting points of wax mixtures. The apparatus used comprises a brass plate to which twelve aluminum pellets are fastened by means of the waxes the melting points of which are to be determined. The melting point is the temperature at which a particular pellet drops from the brass plate. Typical melting point graphs are given for mixtures of paraffin, beeswax, candelilla, ozokerite, carnauba, and Montan waxes.

Flow Properties of Asphalts, R. N. TRAXLER, *Ind. & Eng. Chem.* **30** (1938), pp. 322-4.

In the processing, handling, and utilization of asphalts, their flow properties are highly important, and the usefulness of asphaltic materials in service is dependent to a great extent upon their rheological characteristics. Although numerous empirical tests such as penetration and ring and ball softening point have been widely used to evaluate the consistency of asphalts, most of these measure two or more properties simultaneously. The purpose of the author is to describe briefly the rheological methods that have been useful in investigating the flow properties of asphalts and to point out some of the advantages to be obtained by the use of these absolute methods of measurement. Methods are described for measuring low and high viscosities in absolute units and for evaluating the flow of nonviscous fluids. The capillary tube or rotating cylinder type of viscometer is recommended for low viscosities (less than 50,000 poises). The latter instrument, or a viscometer utilizing the principle of the falling coaxial cylinder, is suggested for measuring the viscosity of highly viscous asphalts. The flow properties of nonviscous bituments (e.g., most air-blown asphalts) can best be evaluated with a rotating cylinder type of viscometer. Properties of asphalt that have been recognized by means of sensitive rheological methods are the existence of viscous and nonviscous asphalts, the phenomena of age hardening, thixotropy, and elasticity, the precise evaluation of change of consistency with temperature (susceptibility), and the evaluation of mineral powders as fillers by measuring the viscosities of viscous asphalt-mineral mixtures.

Study of Ball Packings for Laboratory Rectifying Columns, A. R. GLASGOW, JR., AND S. T. SCHICKTANZ, *J. Res. Natl. Bur. Standards* **19** (1937), pp. 593-603 (Research Paper No. 1049).

The purpose of the investigation was to ascertain the effect of (1) nature, (2) surface area, and (3) size of the packing material on the efficiency, hold-up, and related properties of laboratory columns. Ball type packing was selected because the surface area could be easily determined, the area of contact between individual units is small, the distribution of the packing is fairly uniform, and the volume of free space is practically independent of the size of the balls. The binary solution composed of $(CH_2)_2Cl_2$ and C_6H_6 was used in the test. The column was 25.8 mm. x 140 cm. Balls of glass 2.95 and 3.80 mm. in diameter, of lead 2.05 and 4.05 mm. in diameter, and copper 4.00 mm. in diameter were studied. The results were compared with those obtained when brass jack chain packing was used. Determinations were made of column hold-up, vapor velocity, and surface area of packing. The chains and the lead balls of 2.05 mm. diameter gave the greatest efficiency. It was concluded that the heat conductivity and the nature of the packing material had no effect on the efficiency of separation, liquid-hold-up, or throughput of stills. The efficiency of separation is directly proportional to the total surface area exposed in a packed column, and is approximately linear with the reciprocal of the diameter of the balls. Column hold-up was found to be approximately linear with the total

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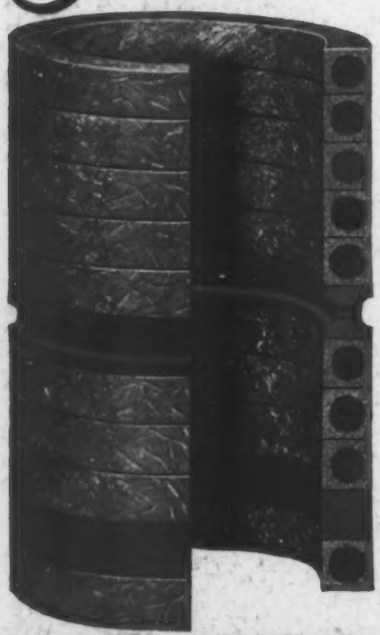

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surface area of the packing. Data are presented in detail in four tables and two figures.

Packing Materials, M. R. FENSKE, S. LAWROSKI AND C. O. TONGBERG, *Ind. & Eng. Chem.* **30** (1938), pp. 297-300.

In a previous study of packing materials the columns used had an inside diameter of 0.62 to 0.80 inches. Data on a 2 inch diameter column were incomplete, but are now given. The helix-type packing was again found to be more suitable for fractional distillation columns than any other type of packing material, both as regards efficiency and throughput. It was found that for certain packing materials, particularly the wire helix type, the decrease in efficiency between columns of 2-3 cm. and 5 cm. in diameter was not as marked as expected. Good efficiencies were found to be possible in 5-cm. diameter columns. With fine wire helix type of packing in 5-cm. diameter columns it was possible to obtain good throughputs and from forty to fifty theoretical plates in a column 100 inches long. With certain types of packing materials it was found to be possible to have a pressure drop of 0.2 to 1.0 mm. of mercury per theoretical plate, and at the same time to obtain reasonable throughputs and efficiencies. Certain packing materials were found to possess relatively high efficiencies, but to permit only low throughputs. The wire helix type of packing combines high efficiency and good throughput, with low pressure drop per theoretical plate.

High-Vacuum Gas-Analysis Apparatus, E. C. WARD, *Ind. & Eng. Chem. Anal. Ed.* **10** (1938), pp. 169-71.

The method and apparatus for the accurate fractional analysis of low-boiling hydrocarbons is described, in which a vacuum of the order of 1 mm. of mercury absolute pressure is used. Separation is accomplished in a condenser train with temperatures controlled by liquid air. A small gaseous sample, usually about 150 cc. is sufficient for a complete analysis. The time required for an analysis is approximately two and one-half hours. The ease of separation of two hydrocarbons varies directly with the ratio of their vapor pressures at the particular temperature employed. This ratio increases materially as the temperature is reduced. Therefore it is desirable to effect a separation at the low temperatures attainable under high vacuums. It is stated that individual components are determined within 0.02 to 0.1 per cent, depending on their concentration in the original sample. Results secured by this method have been used for equipment design and plant control over a period of years. Samples of typical analyses are given.

Determination of the Mercaptan Content of a Gasoline, W. KRAUSE, *The Chemist Analyst* **27** (1938), Jan., p. 14.

One hundred cc. of sour gasoline that has been washed with dilute sodium carbonate to remove hydrogen sulfide, is titrated with a copper solution prepared in a manner described, and so that one cc. of the solution equals one mg. of mercaptan sulphur per 100 cc. of gasoline. For the use of treaters in the refinery a chart can be made whereby the number of cc. of copper solution will give directly the amount of sulfur required to break out the mercaptan from any given quantity of oil. If the Hoover process of treating with copper chloride and clay is used, one mg. of mercaptan sulfur per 100 cc. will require 0.01 cu. ft. of oxygen per barrel of gasoline.

An Instrument for Indicating and Recording Traces of Hydrogen Sulphide in Coal Gas, J. B. REED, *Jour. Soc. Chem. Ind.* **57** (1938), pp. 43-4.

Although the instrument described was developed in connection with the detection of hydrogen sulphide in coal gas, it should be equally applicable to other gases. The author states that a suitable test for control purposes must be sensitive and capable of dealing with concentrations of hydrogen sulphide well below one part in a million. In the development of the instrument the requirements were that it should be simple and rapid in application, and that it should give a continuous record. These requirements are not satisfied by any existing instrument or method. A stain of lead sulphide is formed on a strip of impregnated paper, through which the gas is passed. Complete absorption takes place at gas rates up to three cubic feet per hour per square inch of paper. Measurement of the extent of stain is made by use of a light-sensitive cell and a suitable source of light. Diagrams of the instrument are given, and a description of many details.

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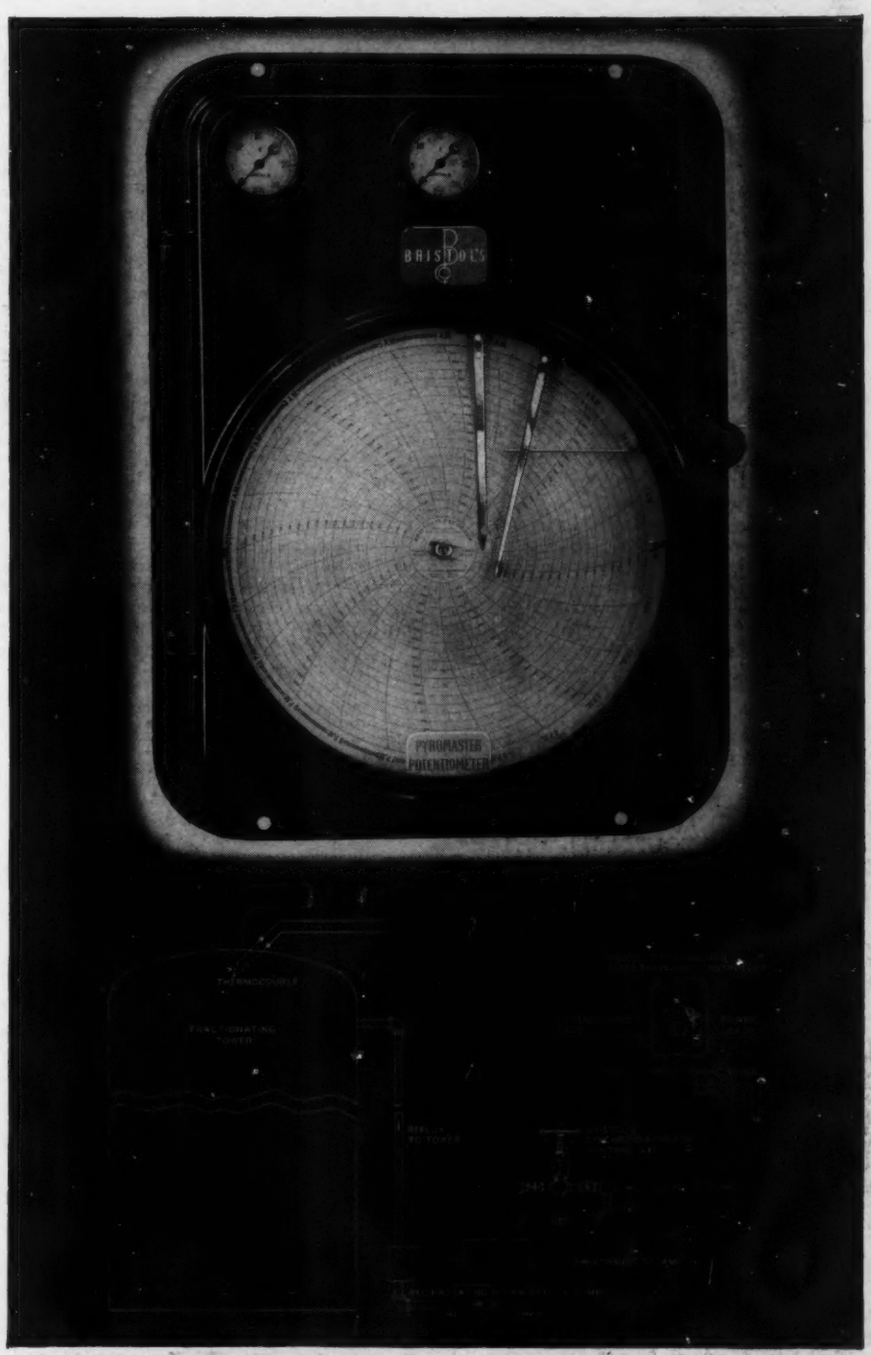

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New Equipment for the Modern Plant

Valves

HENRY VOGT MACHINE COMPANY

Henry Vogt Machine Company, Louisville, Kentucky, announces that Vogt drop forged steel valves made by the company are now available with Parkerized valve bonnets, bonnet nuts,

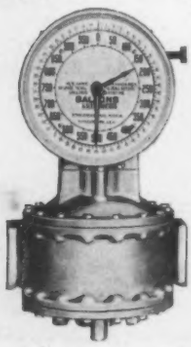
packing glands and packing nuts. Thus rust proof process eliminates galling of threads due to atmospheric corrosion, thereby making it easy to service the valves and maintain high operating efficiency.

Another new feature is the identification disc which is held in place by the handwheel nut. This disc records the valve size, catalog number, working pressure and temperature and style of trim, this making it easy to order proper replacement parts if that should be necessary.

Rotary Meter

PITTSBURGH EQUITABLE METER COMPANY

The Pittsburgh Equitable Meter Company, 400 N. Lexington Avenue, Pittsburgh, Pennsylvania, has recently announced the Pittsburgh Rotary Meter, an addition to the existing Pittsburgh line of meters for measuring petroleum products. This latest development is said to fill a speedy and accurate large capacity meter for bulk-plant and tank-truck service. These meters had over 2½ years of actual service tests before any public announcement was made.



Pittsburgh Rotary Meter

The manufacturer claims there are two factors responsible for the accuracy with which these meters measure. First, they measure through true positive piston displacement. Second, they are precision built to exacting standards.

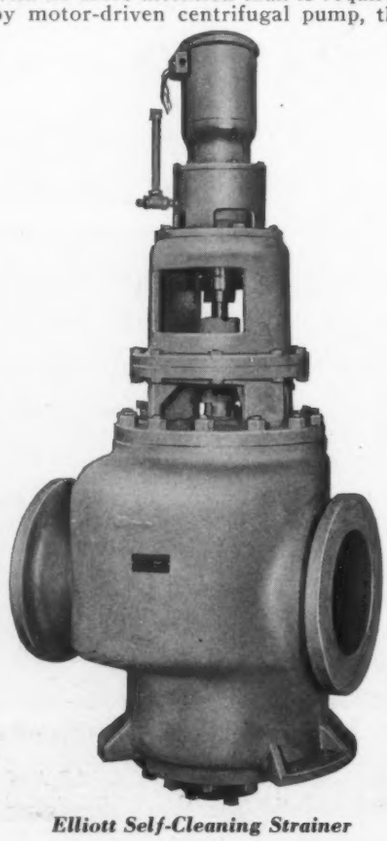
It is stated that due to the extremely small frictional resistance of the meter to pipe line flow, the Pittsburgh Rotary can be successfully used on many gravity flow installations where meters previously have not been considered practical.

The meter is built in two sizes, namely, the No. 250 for 2-, 2½-, and 3-inch services and having a maximum capacity of 250 gallons per minute, and the No. 500 for 3- and 4-inch connections with an operating range up to 500 gallons per minute. A complete line of registers and accessories is available. A full description of the Pittsburgh Rotary Meter will be found in the Pittsburgh Equitable Meter Company's Bulletin OG-121, which will be sent to those interested upon request.

Strainer

ELLIOTT COMPANY

Elliott Company, Jeannette, Pennsylvania, announces the new Elliott Type K self-cleaning strainer for application where a relatively large quantity of fine dirt, sand, etc., is to be removed from water which has already passed a traveling screen or conventional twin or single strainer. Under such conditions a twin strainer is not practical, due to the enormous basket area required to prevent almost constant changing and cleaning the basket. The self-cleaning strainer will deliver a continuous flow of clean water under these conditions with no more attention than is required by motor-driven centrifugal pump, the manufacturer states. The Type K strainer is automatically cleaned by a continuous back-flushing of the straining element obtained by building the straining element of a series of straining cartridges, which fit in channels in a slotted brass cage. A rotating element is slowly turned by a geared electric motor and straining cartridges are blanked off one by one and back flushed by a portion of the strained water. This construction has the added advantage that individual cartridges can be readily pulled out for inspection or replacement. The type T self-cleaning strainer is available in sizes from 4-inch to 24-inch for pressures from 25 pounds to 125 pounds gauge. It is not designed for suction service. Either an a.c. or d.c. motor of any electrical characteristics can be furnished.

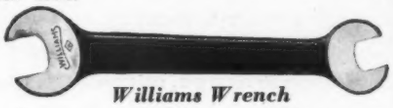


Elliott Self-Cleaning Strainer

Wrenches

J. H. WILLIAMS & CO.

J. H. Williams & Co., 75 Spring Street, New York, N. Y., announces an improved type of carbon steel wrench in a standard line consisting of 50 patterns and more than 1000 sizes. These wrenches are approximately twice as strong as old-fashioned carbon steel wrenches and average 93 percent as strong as alloy steel wrenches of similar size.



Williams Wrench

The unusual strength characteristics of these wrenches are said to result from the fact that they are drop-forged from improved quality carbon steel and specially processed to the exacting specifications of the manufacturer.

These improved wrenches cost no more than old-fashioned carbon steel wrenches, and considerably less than alloy wrenches. Other advantages claimed include: better hand grip and greater and safer bearing on the nut.

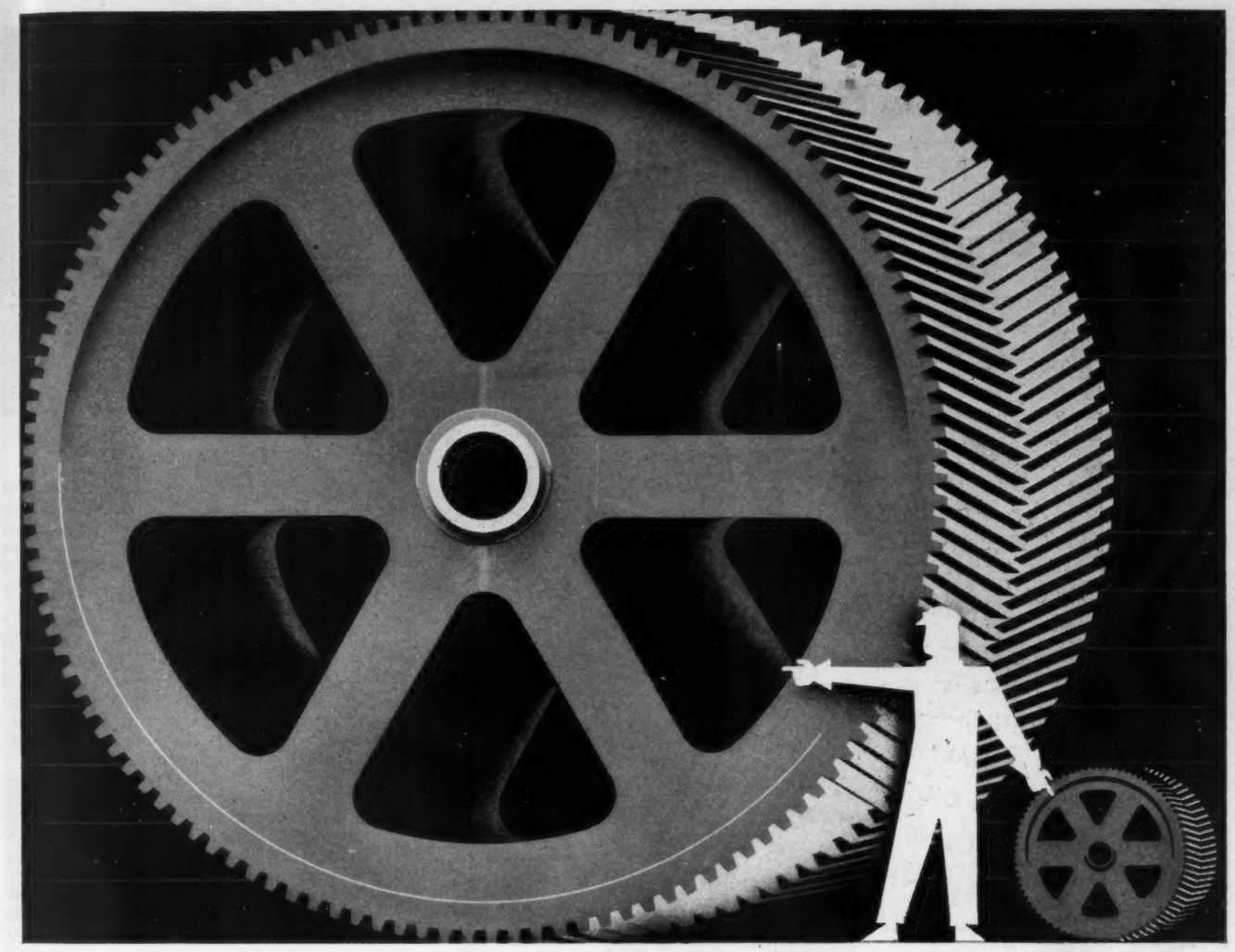
The company recommends its carbon wrenches for most industrial uses and its chrome-molybdenum wrenches for automotive and other purposes where operation in close quarters is required, where higher polishing and chrome-plating is desired, or where that extra 7 percent of strength is essential.

Air Filter

STAYNEW FILTER CORPORATION

Staynew Filter Corporation, Rochester, N. Y., manufacturers of Protectomotor products, recently announced a new dry type air filter possessing advantages for industrial and domestic air conditioning. The new filter, known as the Wire-Klad, has, among others, the particularly desirable feature of flame-resistance — fulfilling the provisions set forth in Section 150 of the National Board of Fire Underwriters, Pamphlet No. 90. Thus its installation is practical in many instances where fire hazard might otherwise exist.

The descriptive name, Wire-Klad,



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In the large gear simple annealing, normalizing and drawing proved sufficient to produce uniformly good physical properties. The smaller gear permitted oil quenching and drawing to even higher physical properties. And, despite the wide variations in sections, no casting defects or machining difficulties were encountered in either of the two products.

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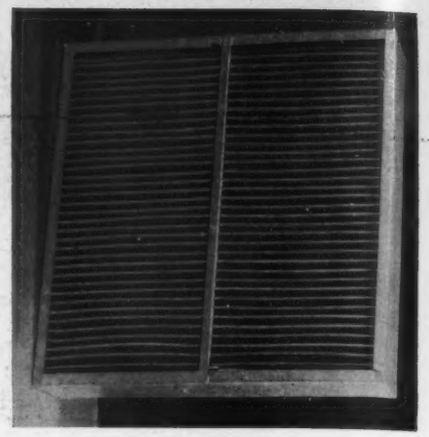

Stanew Filter

refers to the wire mesh reinforcement of the fins. The fin construction affords large filtering area in relatively small space. The wire mesh reinforces the filtering medium so strongly that the filter can be cleaned indefinitely by high pressure air or vacuum.

Several kinds of filtering media to suit varying conditions are available. The most usual are cotton or a wool felt-like material known as Feltex. This latter medium is practically impervious to the passage of even microscopic dust particles, yet offers extremely low resistance to air flow.

Economy is an important point in favor of this new air filter. Although the highest grade materials and workmanship are used throughout, the initial cost is low, due to careful design and the ingenious use of wire mesh.

If exposure to oil or greasy substances makes cleaning with a solvent necessary, the wire reinforced filter insert can be easily lifted from the frame. This filter also possesses the advantage of low replacement cost when finally worn out, as wire reinforced filter insert only need be replaced.

Standard and special sizes are available. There are three standard depths, 2, 4 and 6 inches, and four standard sizes, 20 x 20, 16 x 20, 16 x 25 and 20 x 25-inch. With the thought in mind that many installations require special sizes, these will be furnished at no extra cost if within reasonable limits.

Submersible Pump

BYRON JACKSON COMPANY

Byron Jackson Company, Los Angeles, has placed on the market a new submersible deepwell turbine pump. In this design the motor is below and not above, the turbine bowls. The propelling shaft is very short and the unusually long, small-diameter motor operates submerged at all times in the well water. However, the liquid pumped does not come in contact with the electrical parts or motor bearings, as these are enclosed in an oil-filled case with a mercury seal where the shaft passes through at the top. The turbine and the submersible motor form a compact unit that is attached to and supported by the discharge pipe. A submarine armored cable and a small copper oil tube, form the only connection (aside from the discharge pipe) between the pumping unit and the ground surface. The submersible is said to operate equally well and without frequent at-

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SUN
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tention, in deep or shallow wells, crooked or straight wells, sumps or natural bodies of water.

Naturally, this new unit embodies many engineering features that are new to the turbine pump industry. The motor is a squirrel cage induction type and its rotor is carried on two ball bearings, one of which is a radial thrust to take both the small weight of the rotary parts, and the hydraulic load. The other ball bearing is of radial type, and its chief function is to center the rotor. A high dielectric oil is circulated through the entire windings at all times and, although the small copper tube affords a means for replenishing the oil supply, motors have operated continuously for several years without adding to or changing the oil supply.

Water is sealed out at the top by mercury in a rotating cup that is attached to the motor shaft. A cylindrical sleeve is placed around the motor shaft, with one end attached to the motor casing and the other end submerged in the mercury. Thus the water and the motor oil are sealed off on their respective sides.

Since the first unit was put in service in February, 1929, there have been some 12,000 horsepower of Submersible units installed. The first pump, set 450 feet in a well and powered with a 50 horsepower motor, still delivers its rated 250 G.P.M. against a 475-foot head.

Complex Piping Installations Simplified With

BONNEY WELDOLETS·THREDOLETS

THE bigger the piping job, the greater the number of branch pipe take-offs—the bigger your savings will be when Bonney WeldOlets and ThredOlets are used.

WeldOlets and ThredOlets are the only welding outlets that eliminate all cutting, threading and fitting of the main pipe. WeldOlets and ThredOlets are the only welding outlets that make branch pipe connections of full pipe strength.

In addition, their funnel-shaped outlets improve free flow conditions and reduce turbulence and friction to a minimum.

Because of these features and the savings which WeldOlets and ThredOlets make possible, engineers, contractors and others responsible for efficient piping installations have standardized on them when making branch pipe take-offs either for maintenance or new construction.

Improve your next piping job and save with these fittings. Once used, you'll standardize on them.

For full information write for Bulletin WT23 or see your nearest distributor.

The names "WeldOlets" and "ThredOlets" are Bonney trade marks registered in the United States Patent Office. Full patent coverage for designs, principles and construction has been granted in the United States and foreign countries.

They are easily installed!

WeldOlets and ThredOlets are quickly and easily installed. Select the position of the outlet anywhere on the main pipe, mark center lines and tack the fitting into position.

Then weld by electric-arc or oxy-acetylene method. A leak-proof joint of full pipe strength is obtained.

On two-inch outlets or larger the button is removed after installation. A full inspection of the inside of the joint is possible when WeldOlets and ThredOlets are used.

A simple Vee weld is used for attaching the branch when WeldOlets are used. If ThredOlets are used, the branch is screwed into position.

BONNEY FORGE & TOOL WORKS, Allentown, Pa.

WELDOLETS·THREDOLETS

. . . Welded Outlets for Piping . . .

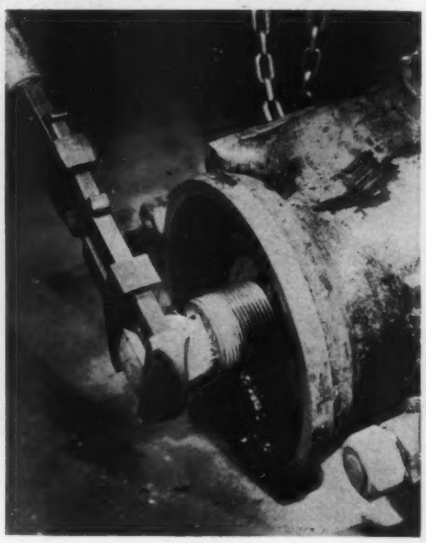
Stocked by Leading Distributors

Extractor

REPS TOOL INC.

Reps Tool Inc., 220 Delaware Ave., Buffalo, N. Y., announces the Reps Extractor which completely answers industry's age-old riddle of extracting broken pipe and studs, it is claimed.

The patented four-point grip prevents Reps Extractor from reaming and assures strong bite without hammering or pounding. Shallow grip greatly lessens any expansion and jamming.



Reps Extractor

Built-in reamer automatically removes burrs from pipe, eliminating interference with extractor's bite and minimizing cause for expansion of broken piece. The extractor pulls rather than reams.

Compact one-piece design makes the extractor strong, durable and easy to handle. Heat-treated forged steel with a Brinell hardness of 490 gives a toughness harder than any material with which the extractor will come in contact, such as iron, steel, bronze, brass or special alloys. Electrolytically plated cadmium provides permanent rustproof surface. The extractors release instantly from bite after job is completed.

Broken pieces of pipe are removed by inserting the extractor straight into the pipe so all four points bite at the same time. Turn the extractor with a wrench in the direction of the extractor's threads. To remove studs, screws or bolts, drill a hole in the exact center of broken part just deep enough for the extractor to get its shallow grip.

The complete set of only 10 Reps extractors fits every size and class of pipe, standard, heavy or extra heavy, from ⅛-inch to 2-inch. This same set of tools fits every size of studs, screws and bolts from 7/16-inch to 3½-inch.

Furnaces

M. H. DETRICK COMPANY

M. H. Detrick Company, Chicago, is distributing a new furnace construction catalog, "The Evolution of Furnaces," which deals with furnace design as applied to all types of furnaces. On these pages is an interesting outline of the development of furnace construction

YOU CAN WELD 1001 JOBS 15% FASTER WITH THE 6-IN-1 *"Shield-Arc"*

THE JOB SELECTOR of a Lincoln *"Shield-Arc"* Welder enables you to lower costs by having your pick of any TYPE of arc. It gives you selectivity and range equal to 6 special welders. You can get an arc that is especially designed for overhead or vertical work, one for high-speed, deep-groove welding, one for delicate tool welding, one for sheet metal, one for alloys, etc. In fact, you can get an arc of *any* characteristics you need to do the best welding possible on all classes of work. And at each setting of the Job Selector, you can get any SIZE of arc with *"Shield-Arc's"* Current Control for any one of 1001 welding jobs.

Users of the 6-in-1 *"Shield-Arc"* report that its selectivity and range increases welding speed, improves weld quality and lowers costs as much as 15%. Mail the coupon for a free copy of a booklet which gives complete details.

LINCOLN

LARGEST MANUFACTURERS OF ARC WELDING EQUIPMENT IN THE WORLD

THE LINCOLN ELECTRIC CO., Dept. M-485, Cleveland, O.

Send a free copy of the book explaining how I can lower welding costs with the *"Shield-Arc"* Welder.

Name _____ Position _____

Company _____

Address _____

City _____ State _____

over the last 25 years. This new 64-page book is practically a manual on modern furnace construction. It deals with the latest methods of construction for arches and walls, engineered to give long life under severe conditions. Furnaces of all types are covered, including those for burning pulverized fuel, oil and gas and stokers of various types. Specialized furnaces are shown, including wood burning and sugar mill bagasse. In each case, drawings of actual furnaces are shown, demonstrating the latest methods of construction. Interesting developments in cracking stills of various types are dealt with, showing how temperatures are controlled and heat losses reduced in refinery processes.

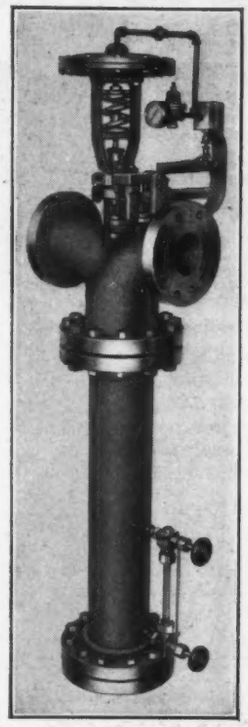
The book is a technical one which can be used for reference purposes since it covers dimensional details for arches of various types and air cooled and insulated walls.

Desuperheater

NORTHERN EQUIPMENT COMPANY

Northern Equipment Company, Erie, Pennsylvania, recently introduced to the market the new Copes Desuperheater, which is designed for either total or partial elimination of the superheat from steam to be used for process work, or for auxiliaries built for reduced-temperature steam. It operates on steam from 212 to 1100° F., maintaining within close limits the desuperheated steam temperature, regardless of changes in temperature of the desuperheated steam.

The desuperheater is installed in the steam line as a self-contained unit. The only connections needed are a water supply for desuperheating, a water or air pressure line for the diaphragm operator, and a drain to carry off excess condensate brought over by the steam when the desuperheater is first cut into service.



New Copes Desuperheater

The flow of cooling water is controlled at the spray nozzle. A constant pressure drop is maintained across the nozzle, permitting a continuous supply of cooling water to be sprayed into the superheated steam in exact proportion to the demands, from minimum to maximum flows. This fact, plus the positive action of the thermostatic temperature control element, assures dependable operation and sensitive control under all conditions.

Boiler feed water can be used as a cooling water supply. Air or water can be used to actuate the pilot operator of the water control valve. The unit is easily dismantled for cleaning by removing the lower cover of the mixing chamber.

Welding Electrode

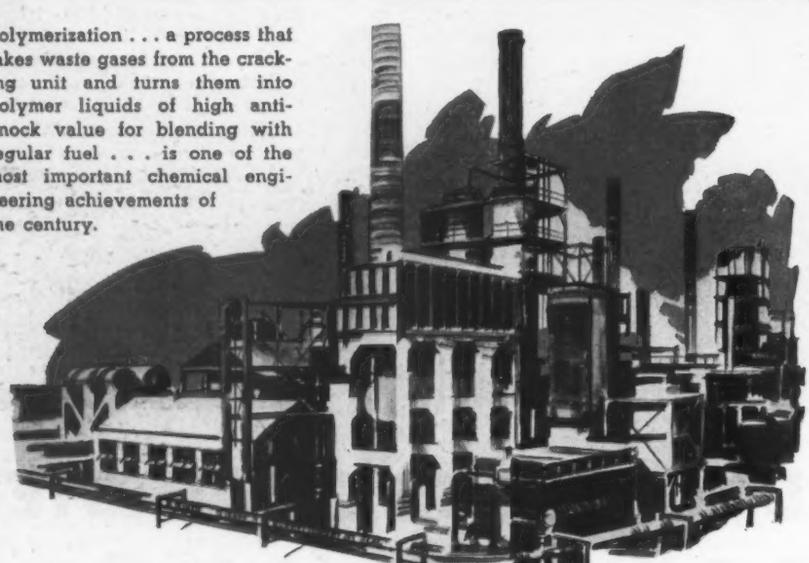
HARNISCHFEGER CORPORATION

Harnischfeger Corporation of Milwaukee announces Smootharc "Harmang"—another in its line of Smootharc welding electrodes. Designed for welding on parts subject to heavy impact, such as manganese castings, "Harmang" supplied the necessary toughness and hardness. Its base metal is nickel manganese steel, ranging from 11 to 14 percent nickel manganese, 3½ to 4½ percent nickel. Carbon content is in excess of 1 percent.

The slag coating which stabilizes the arc and protects the metal against loss of carbon and manganese is kept to a minimum, so as not to interfere with

PETROLEUM *opens broad new highways to the future*

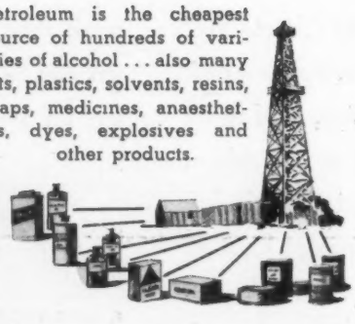
Polymerization . . . a process that takes waste gases from the cracking unit and turns them into polymer liquids of high anti-knock value for blending with regular fuel . . . is one of the most important chemical engineering achievements of the century.



The new 100-octane-rating aviation gasoline increases engine power by almost a third! A memorable milestone in man's conquest of the air.

New, solvent-refined lubricants make possible higher and higher speed automotive engines.

Petroleum is the cheapest source of hundreds of varieties of alcohol . . . also many fats, plastics, solvents, resins, soaps, medicines, anaesthetics, dyes, explosives and other products.



SOLVAY

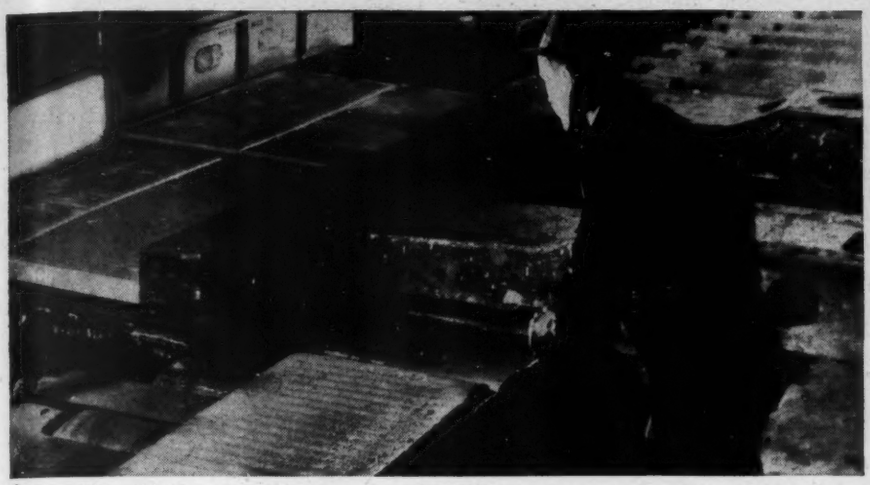
. . . keeping pace with the swift progress of the petroleum industry

New processes, new products, make ever more rigid demands on the quality of alkalies used by the petroleum industry. Producers, large and small, know that it pays to place the job of meeting these requirements in the able hands of SOLVAY, America's oldest and largest producer of alkalies. SOLVAY will fill your special requirements as efficiently as your regular needs.

CAUSTIC SODA • SODA ASH • CAUSTIC POTASH
CHLORINE • CAUSTICIZED ASH • PARA-DICHLOROBENZENE
POTASSIUM CARBONATE • AMMONIUM BICARBONATE
MODIFIED SODAS • CALCIUM CHLORIDE
AMMONIUM CHLORIDE • SODIUM NITRITE • SALT

SOLVAY SALES CORPORATION • *Alkalies and Chemical Products Manufactured by The Solvay Process Company* • 40 RECTOR STREET, NEW YORK

HOW RESEARCH HELPS CUT YOUR FUEL BILL

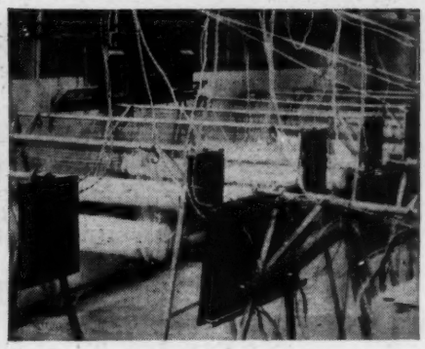


1 Less than thirty years ago, there was no satisfactory insulating material for high-temperature industrial equipment. No known substance combined low conductivity and the necessary heat resistance. But in 1912, when Sil-O-Cel Brick and other diatomaceous silica insulations appeared, heat waste ceased to be a necessary evil. Later developments of the J-M Insulation Research Laboratory, notably Superex Blocks, made it possible for industry to bring heat even more completely under control. Today, there is a Johns-Manville Insulation for every type of heated or refrigerated industrial equipment.

2 3200° F. is the temperature of this Ajax Northrup electric furnace, used to test high-temperature insulations in the J-M Laboratories. Such temperatures, far above the ordinary range of industrial processes, make it possible to check in advance the exact behavior of J-M insulations under severe conditions.

3 Electrical current, accurately measured, is the source of heat for all thermal-conductivity tests in the J-M Laboratory. Power input to any heater in the laboratory may be measured at this switchboard to within ½ of 1%.

4 Measuring the efficiency of high-temperature insulating materials is difficult, for ordinary testing equipment breaks down under high heat. But this J-M testing unit gives accurate conductivity data up to 2600° F.



5 Pipe Insulation is tested for thermal conductivity on these electrically heated pipe sections. The room is kept at constant temperature under thermostatic control. Accuracy is safeguarded at every point.

6 "Jack" Switchboard to which is connected the thermocouples used in the various testing units. Here, with the aid of a single precision potentiometer, temperatures are measured to within ⅓ of 1° F. Temperatures may be measured at approximately 800 different points.

SINCE its beginning over 80 years ago, Johns-Manville has pioneered in the development of materials and methods to help industry control heat, and use it with maximum efficiency and economy.

Today, it is conservatively estimated that J-M Insulating Materials are saving American Industry over $250,000,000 annually in fuel alone . . . bringing substantial benefits, too, through improved temperature control and better working conditions. In large measure, this achievement can be credited to the J-M Insulation Research Laboratory at Manville, N. J., scenes from which are shown here.

The story of this laboratory and of what it is doing to solve tomorrow's insulation problems is told in the handbook, "Heat." This interesting book also gives useful information on the full line of J-M Insulations for all industrial purposes. If heat conservation is one of your problems, you'll find this book most helpful. For your copy, write Johns-Manville, 22 East 40th Street, New York, N. Y.

Johns-Manville

INSULATIONS FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE CONDITION

the rapid cooling required to form an austentitic deposit. With cold working such as hammering and peening, the soft manganese deposit becomes an extremely hard martensite layer which offers great resistance to impact and abrasion. Smootharc "Harmang" operates with the work negative and the electrode positive, and is built in sizes from ⅛ to ¼ inch diameter, for use with currents ranging from 90 to 140 amperes.

Portable Potentiometer

WHEELCO INSTRUMENTS COMPANY

Wheelco Instruments Company, 1933 South Halsted Street, Chicago, offers a new portable potentiometer specially designed and built for use in field or laboratory service.

This precision instrument is built in three different models: Model 310—with cold junction compensator; Model 320—with cold junction compensator and run-up box; Model 330—with cold junction compensator, run-up box, and standard thermocouple line compensating rheostat.

When used with thermocouples, this unit becomes a checking instrument, whose accuracy and sensitivity is far higher than any direct reading pyrometer.

Standardized with regulation standard cell, and is equipped with precision slide wires and multipliers. Galvonometer is of regulation dual taut suspension type, complete with lock and zero adjuster.

Scales are obtainable calibrated in millivolts or in degrees Fahrenheit or Centigrade, or both. It comes complete with instruction book and voltage equivalent tables.

Wheelco Potentiometer

THE advantages of the Sharples Centrifugal Acid Treating Process when treating with Fuming Acid are too important to neglect. Very real savings in oil and acid are not all. Time is greatly reduced. Accurate temperature control is easy. So is change-over to different stocks. Sulphur dioxide control is much simplified by the compactness of the equipment.

Sharples has centrifugal experts who have literally lived with petroleum problems for years. Would you like to talk with one?

☆

The Sharples Specialty Company
2335 WESTMORELAND STREET
PHILADELPHIA, PA.

Oil Seal

GARLOCK PACKING COMPANY

Garlock Packing Company, Palmyra, New York, has announced a new patented oil seal which is split or cut open and can be easily installed without dismantling the machine. This new product is called the Garlock Split-Klozure.

It is applied by placing it around the shaft in the same manner as an ordinary packing ring is applied, instead of sliding it over the end of the shaft. The company states that with the development of this Split-Klozure the problem of providing an oil seal which can be installed without dismantling heavy machinery is solved. The material used in the new oil seal is the same Garlock compound from which the sealing elements in the regular Klozures are made. It is dense, non-porous and grain-

Garlock Split-Klozure

For Better Performance at Lower Cost, consider these—

"MULTI-LEAVES" for Filter Presses.

(Manufactured under license from Oliver United Filters, Inc.)

LEAF:—Our own improved design and construction. Stocked in 24", 30" and 36" diameter.

Deeper drainage chamber—greater capacity.

"B. W. D." feature (Bottom Waste Discharge)—permits quick and frequent discharge of clay accumulation.

Center Drain—gives better, drier cake.

Reversability—doubles life of leaf.

CLOTH:—New, dense textures allow less fines to pass. Stocked in Monel, KA2 Stainless, and KA2—SMO (4% Moly.). Extra heavy weight gives unusually long life.

CLOSURE:—Welded method of attachment fuses leaf and cloth into one leakproof unit.

"SINGLE DISCS" for Graytowers (Claytowers).

CLOTH:—Weaves created especially for this work.

Stocked in Monel, KA2 Stainless, Swedish Iron.

Widths up to 14' 00".

Advanced welding technique permits manufacture of Single Discs up to 20' 00" diameter.

Single Discs preferable to segments—no joints, no leaks—cost actually less, having no waste overlaps.

Largest discs can be passed through manhole.

Outside edge finished with "Weldedge" binding which protects screen and prevents injury.

Your order in the morning brings shipment same evening.

MULTI-METAL
WIRE CLOTH COMPANY
INCORPORATED
1356 GARRISON AVE., BRONX BORO, N. Y.

WIRE CLOTH
FILTER CLOTH
ALL MESHES
ALL METALS

less. It is inherently resilient and oil and heat resistant and has a low coefficient of friction. The new seal is made in any shaft size from 3 inches to 52 inches in diameter.

Electric Soldering Pliers

IDEAL COMMUTATOR DRESSER COMPANY

Ideal Commutator Dresser Company, 1531 Park Avenue, Sycamore, Illinois, reports that in answer to the increasing demand for a smaller low-capacity soldering unit, that would heat electrically, sweat joints without unsweating adjacent connections, and eliminate the open flame hazards, it has introduced the new No. 2 "Midget."

This tool has been designed especially for soldering small objects and for work in restricted spaces and for ease of operation. A few typical applications are: For soldering small lugs and terminals up to 150 amperes, in close quarters on switchboards, motors, generators—for various small radio and appliance soldering—for sweating joints on small copper tubing and fittings up to ⅜-inch diameter.

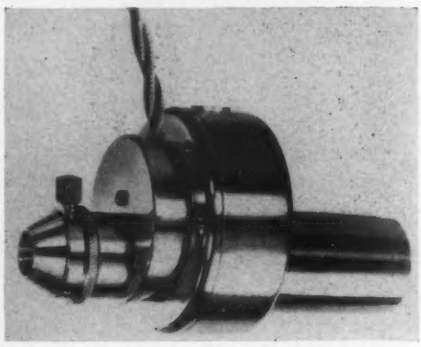
The small power requirement (300 watts) permits the use of the unit on any standard lighting circuit without danger of overloading the circuit or burning out fuses.

The pliers are made of cast bronze (long, slender, small jaws), so that they will fit into restricted spaces. The jaws are hinged at the back and have a spring, which holds them normally in the open position.

Radiation Thermometer

THE BRISTOL COMPANY

The Bristol Company, Waterbury, Conn., announces a new Radiation Pyrometer which uses as a temperature-sensitive unit, the Ardometer. This instrument measures the surface temperature of hot objects or masses above 1000°F., when the Ardometer unit is sighted so that it picks up the heat rays



Bristol Radiation Pyrometer

emitted. The temperature is recorded on one of Bristol's potentiometers—on a round- or strip-chart recorder—or is indicated on a millivoltmeter pyrometer.

The Ardometer has this important feature: it can be sighted directly on the object in the furnace and in this position it measures instantly the temperature of the object itself. It follows with fidelity the temperature changes in the material on which it is sighted.

Oil Strainer

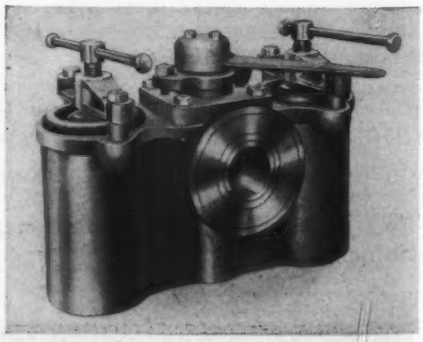
THE SHEFFLER-GROSS COMPANY

The Sheffler-Gross Company, Inc., Philadelphia, Pa., has developed the Duofold Suction Oil Strainer which is made of semi-steel and has two perforated baskets held in place by the covers. This duplex construction allows one strainer to be cleaned while the other is in operation.

The strainer baskets are large and have a straining area much greater than that of the oil intake pipe.

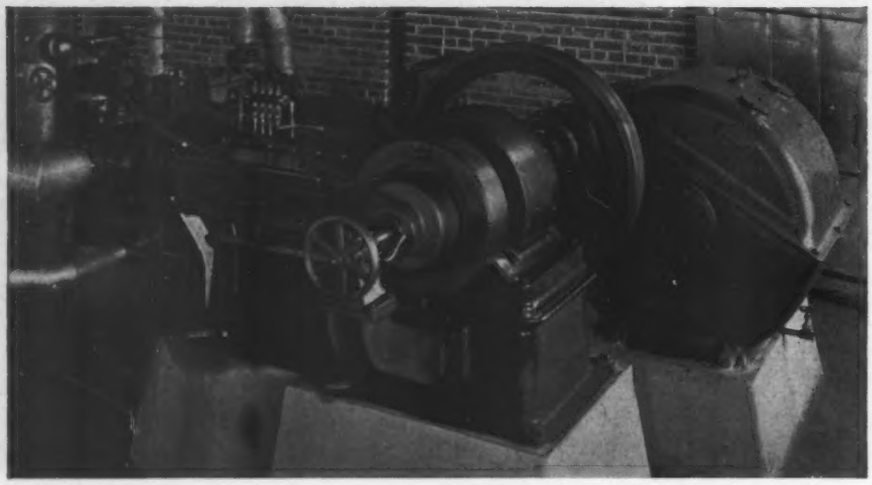
Cleaning of one of the strainers is easily accomplished without interfering with the operation of the system. It is only necessary to turn the plug cock, deflecting the oil through the other strainer and remove the basket to be cleaned.

Duoflo suction oil strainers are made in five sizes, 1½, 2, 2½, 3 and 4 inches, to suit the requirements of the system installed. All suction strainers are



Sheffler Oil Strainer

TROY-ENGBERG STEAM ENGINE



THIS COMPANY'S CHOICE FOR PUMP DRIVES

The photograph above shows one of two horizontal Troy-Engberg Steam Engines recently installed in the Bay Petroleum Corporation's refinery in Denver. This company wanted—*and got*—for its pump drives three things: dependability, operating advantages, and economy!

There's no need to re-emphasize the dependability of the modern steam engine. That's proved beyond question. As for operating advantages, it has many: quick-starting; high-starting and running torque; wide, easily controlled speed range; flexibility; conservative speed; no explosion hazard. It gets its name for economy from its low maintained steam rate; low oil consumption; little attention; and elimination of major expense and maintenance. Bulletin 101 tells more about its economy . . . more about how 43 leading companies can drive equipment for an average of ½ cent per kwh. Send for a copy.

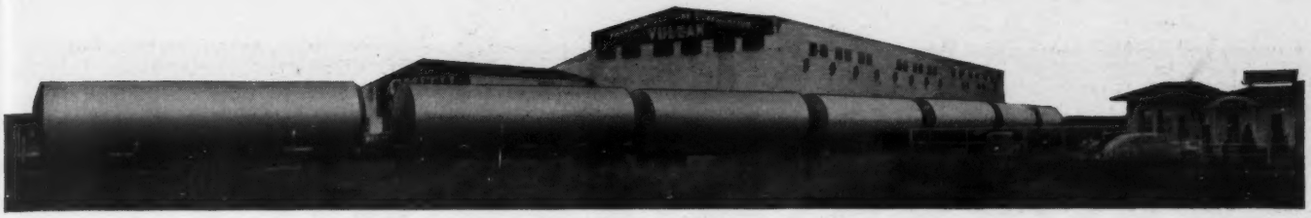
TROY ENGINE AND MACHINE CO.
ESTABLISHED 1870
950 Railroad Ave. Troy, Pa.

Troy Engine & Machine Co.
950 Railroad Ave.
Troy, Pa.
Gentlemen:—
Please send us a copy of Bulletin 101 which describes in detail the results of the surveys referred to above.

Individual & Title .....

Company .....

Address .....



GASOLINE STORAGE TANKS 10 ft. diameter by 40 ft. long, 40 lbs. pressure.

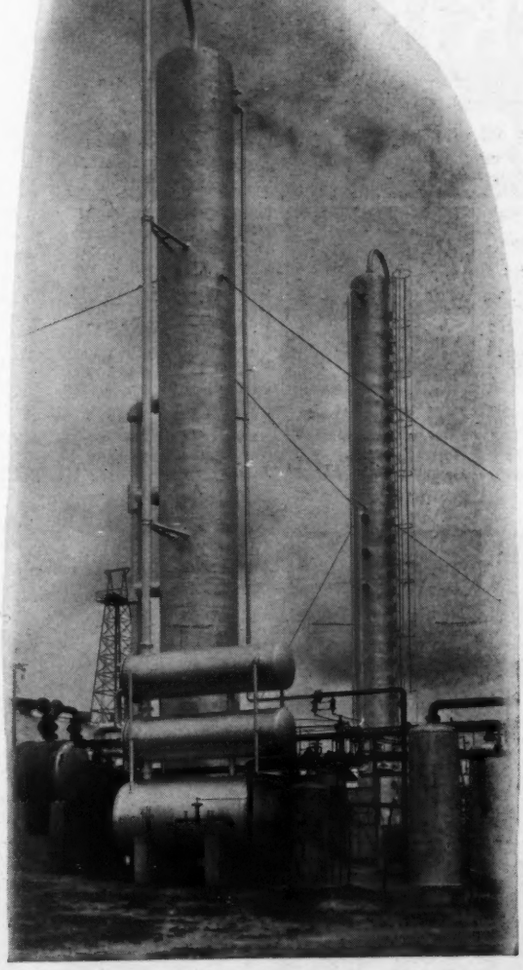
V U L C A N

TULSA, OKLAHOMA

Engineers and Manufacturers

GASOLINE PLANT & OIL REFINERY EQUIPMENT

General Steel Plate and Pressure Vessel Construction



All Materials and Workmanship Manufactured Under ASME or API Requirements When Specified

Complete VULCAN Gasoline Plant in East Texas

BUBBLE TOWERS 7/16 in., 5 ft. diameter by 68 ft. BUBBLE TOWER 7/16 in., 7 ft. diameter by 89 ft.

flanged, and drilled to American Standard Specifications. Each assembly is hydrostatically tested to 150 pounds per square inch before shipment.

Duoflo suction oil strainers can be applied to industrial oil burning furnaces, oil processing lines and in fact any place where oil is used as a fuel or in process.

Gate Valves

THE FAIRBANKS COMPANY

The Fairbanks Company, New York, is offering a new line of U-Bolt Gate Valves, of 150 pounds steam working pressure and 225 pounds gas and liquid pressure. The valves are said to be designed to meet the demand for a rugged valve at low cost, and are adapted to service in the gas and petroleum industries as well as for ordinary steam, water and air line. Simple in design, with but few parts, it can be taken apart, inspected and cleaned with a minimum of effort and time. The valves are made in sizes from ½ inch to 4 inches. They are made with an iron body, are bronze mounted, and in all iron. Relief slots are provided in the threaded bonnet bushing which permit drainage back into the body chamber. This eliminates the possibility of freezing or clogging above the bonnet threads. Extra length pipe threads are provided to prevent long threaded pipe or nipples from damaging the diaphragm, seats or wedge.

THE RIGHT PACKING in the Right Place!

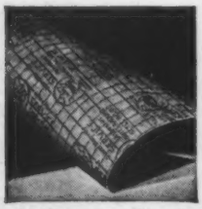
J-M Sea Rings. Absolutely automatic. Save power. Reduce wear on equipment. Last longer.

J-M Kearsarge Rod Packing. Retains its efficiency—note construction of center block.

J-M Centripac. Plaited construction. Specially designed for centrifugal service.

J-M Flax Packings available in various styles to meet a wide variety of service conditions.

J-M Kearsarge Boiler Gaskets assure a perfect seal on handholes, manholes and tube plates.



J-M Service Sheet. Pliable. Resilient. Adaptable to all general sheet packing purposes.

J-M Mogul Packing. An excellent utility packing for general service.

FOR *complete* information on J-M's *complete* line of packings for the oil industry, send for the J-M Packings Catalog. Address Johns-Manville, 22 East 40th St., New York City.

Johns-Manville PACKINGS

For Every Oil Industry Service

JOHNS MANVILLE JM PRODUCTS

Reversible Asbestos Glove

INDUSTRIAL GLOVES COMPANY

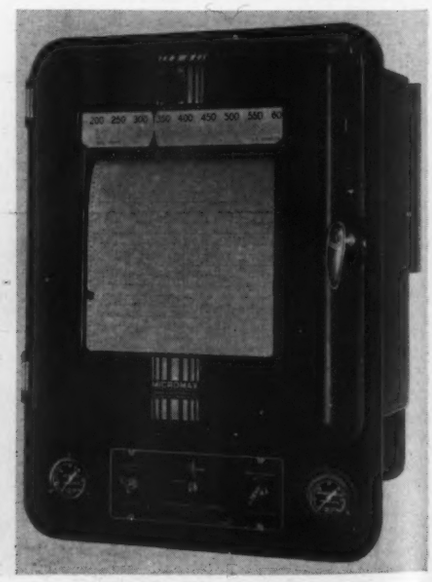
Industrial Gloves Company, 706 Garfield Boulevard, Danville, Illinois, has just placed on the market a reversible asbestos gauntlet glove, known as Safeguard No. 210-S, which fits either hand. The glove is said to afford ample protection in the handling of hot materials, and is said to fit comfortably. The glove is designed without seams on the palm or back of the hand, thus eliminating one of the main difficulties with asbestos hand protection—that of ripping. All seams are in the fingers where there is little strain. The gloves are furnished in any length, either lined or unlined.

Safeguard No. 210-S

Control

LEEDS & NORTHRUP COMPANY

Leeds & Northrup Company, Philadelphia, announces a new air-actuated control, said to be simple and direct of action due to the use of the company's development of a complete, automatic control to embody its Micromax re-



Leeds & Northrup Control

LUNKENHEIMER
350 lb. SP VALVES

for High Pressure Oil, Gas and Hydraulic Service

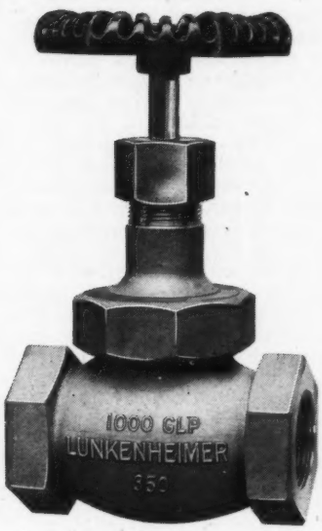


Fig. 1878 Globe
Fig. 1879 Lift Check
Fig. 1880 Swing Check
Fig. 1881 Gate

BRONZE VALVES

350 lb. SP - 550° F.
1000 lb. GLP - 150° F.

STEEL VALVES

350 lb. SP - 580° F.

See these sturdy valves on display at the Oil Show—Lunkenheimer Booth Nos. 67-68, Oklahoma Bldg.

Lunkenheimer Distributors in all oil field centers are prepared to give prompt delivery from stock.

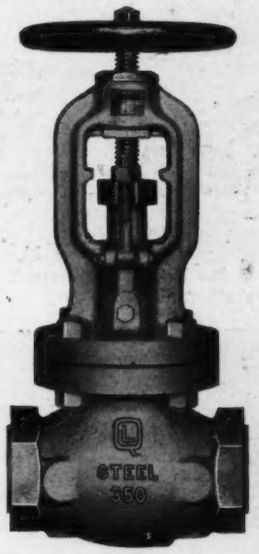
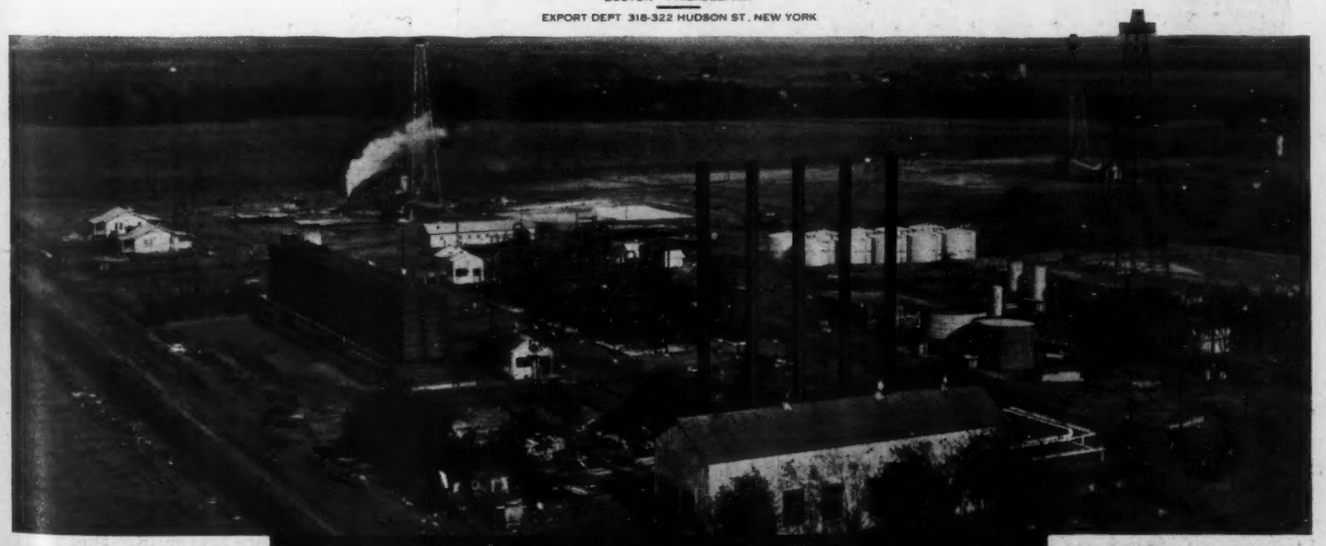


Fig. 1872 Globe
Fig. 1873 Angle
Fig. 1490 Check
Fig. 1869 Gate
Also available with flanged ends.

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO
BOSTON PHILADELPHIA
EXPORT DEPT 318-322 HUDSON ST. NEW YORK



BOILER MOUNTINGS

LUNKENHEIMER VALVES

LUBRICATING DEVICES

corder. Records of actual refinery operation, where this control has recently been used with success to maintain vapor-line temperature of fractionating towers, demonstrates, it is said, the extremely close limits within which, even in the face of large changes in process conditions, this new control maintains temperature. In its complete form the Micromax Pneumatic control employs two balances, an electrical balance for measurements and a pneumatic balance for control. The instrument is all in one compact unit and built like a machine tool and comes from the factory completely assembled ready to install.

Electrodes

METAL & THERMIT CORPORATION

Metal & Thermit Corporation, 120 Broadway, New York, exclusive agents for American Murex Corporation is offering two new electrodes for manual arc welding.

The new Murex vertex electrode is a reverse polarity rod designed for welding mild steel in flat, vertical and overhead positions, and is used for general shop work where positioning of parts during welding is not practical. It is also employed in structural welding, such as, shipbuilding, bridge and building construction.

The new Murex Genex electrode is an all around type that may be used in all positions and readily bridges gaps between plates where assembly fit-up is poor. It is a straight polarity electrode.

These electrodes serve to round out the Murex line, which includes 20 different types of welding rods for mild steel fabrication, the repair of manganese steel parts, the building up of wearing surfaces, and for welding a number of the new high-strength, low-alloy steels.

Pump

ALLIS-CHALMERS MANUFACTURING COMPANY

Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, has recently introduced an improved design of multi-stage pump into the high-pressure pump field. This pump is called the "Doubleton" type because of the use of double suction impellers, and the double balance of the rotating element. The double suction impellers provide axial balance and the positions of the successive volute passages which surround each impeller are made so as to largely equalize unbalanced radial forces on the impellers. These pumps are made with horizontally split casings for pressures 1500 pounds and above. The design and bolting has been so worked out, based on the company's experience with bolting high-pressure, high-temperature steam turbine casings, that no difficulty is experienced in maintaining a tight joint and retaining the advantages of the split casing construction. This pump is suitable for high-pressure applications such as oil pipe lines, boiler feed service, "descaling" pumps in steel mills, etc.

Burette Lamp

FOSTORIA PRESSED STEEL CORPORATION

Fostoria Pressed Steel Corporation, Fostoria, Ohio, recently developed new Model 41-M Burette lamp, specifically designed for use with laboratory burettes. This lamp features the well known ball and socket construction pioneered in the company's lighting equipment.

Two bell type reflectors illuminate the two tubes, the light being supplied by a bayonet type, double contact, 25-watt candelabra bulb in each reflector. The ball and socket joint on each side permits instant adjustment to the particular case. Overall size of 7¼ x 8 inches makes the No. 41-M readily adaptable to the majority of burettes.

Cosmetics for Workers

DAVIS EMERGENCY EQUIPMENT COMPANY

Davis Emergency Equipment Company, 55 Vandam St., New York, announces a new type of protective treatment for the hands of industrial workers. The treatment consists in the use of two different creams (known as No. 1 and No. 2 Eco Protective Creams—Davis) one for protecting the hands during work and the other for use after work.

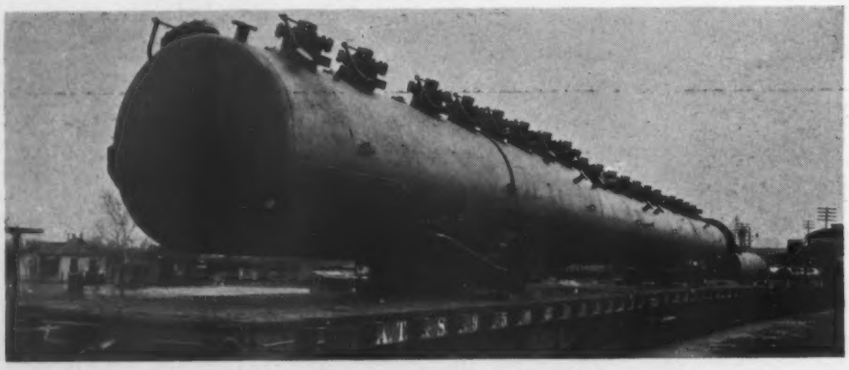
The No. 1-cream is rubbed into the hands, and on the arms, if necessary,

See- TULSA TYPE

See Our Exhibit INTERNATIONAL PETROLEUM EXPOSITION TULSA MAY. 14-21

We invite you to visit our Shops while in Tulsa and see how TULSA TYPE Builds Right! At the Exposition inspect our complete Miniature Natural Gasoline Plant, built to one-sixth actual size.

Latest Design TULSA TYPE Distillation Unit for Natural Gasoline Plant



66-Inch and 78-Inch x 97-Foot TULSA TYPE Naphtha Rerun Tower

Tulsa Boiler & Machinery Co.

WEST TWENTY-FIRST STREET & UNION AVENUE TULSA, OKLAHOMA

Candid talks on Valves — by Hancock

They were all out of step.

. . . but us!

For years the quality and price of Hancock Steel Valves were both sky-high. Our worthy competitors built cheaper valves — sold more.

Maybe we were a little ambitious — but we wanted to sell more Hancocks. So, last summer, we lowered our prices to the competitive level **without changing the Hancock Quality.** We hoped this would increase our production and lower our manufacturing costs.

Well, sir, would you believe it, during the last six months our steel valve business has doubled. And today we are really just getting underway. There are still thousands of valve users who haven't heard that they can now use Hancocks at no premium in price. Doggone, if we don't believe these automobile makers who get their prices down by making more cars have got something.

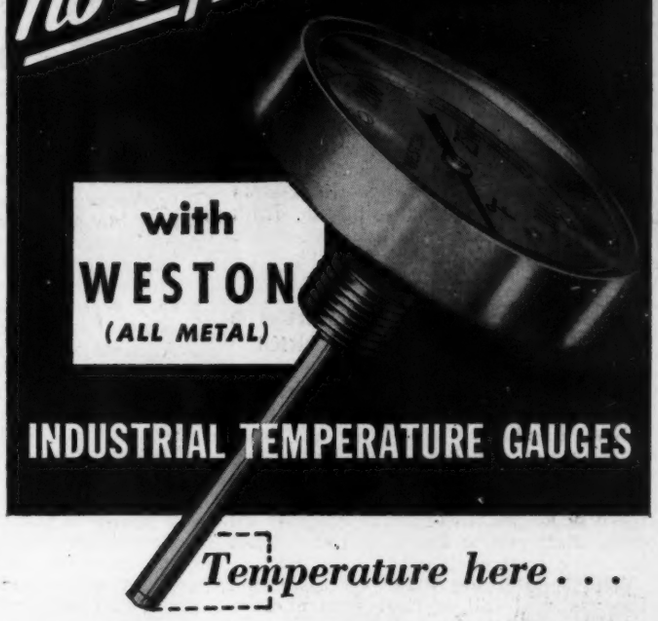
Hancock Valves will continue to be frugal with steam and repair costs. Their hardened stainless steel seats and discs are **habitually tight.** An easily renewable thread bushing rejuvenates old valves for a few cents. The new stainless steel gland nut **cannot rust and stick** . . . insures easy tightening of packing.

Are you one of the many people who would always have liked to use Hancocks but didn't because of their high cost? If so, you'll want a copy of our new Hancock Steel Valve bulletin. Now you pay no more — write Hancock into your next requisition for steel valves and get lower maintenance costs as a bonus.

Hancock Valve Division
Manning, Maxwell & Moore, Inc.
Bridgeport, Connecticut

HANCOCK VALVES

No Capillary Errors



Temperature here . . .

. . . at the bottom of the stem . . . is the true temperature indicated on the dial of the WESTON. No stem corrections ever necessary, no matter how long the stem.

You avoid all necessity for stem corrections when you use WESTON Industrial Temperature Gauges. You eliminate frequent replacements due to breakage, or damage from severe vibration or over-temperatures. You banish all possibility of taking temperatures inaccurately because of poor readability.

All these costly and troublesome problems vanish when you adopt WESTONS. For this new thermometer is ruggedly constructed throughout of stainless steel . . . it has a large, easy-to-read dial with widely spaced temperature divisions . . . and it has an accuracy of 1% over the entire scale.

No matter what your requirement, it will pay you to investigate immediately all the advantages of this improved thermometer. The coupon below will bring you complete data.

Weston Electrical Instrument Corporation,
655 Frelinghuysen Ave., Newark, N. J.
Send data on WESTON Temperature Gauges

Name_____

Address_____

City_____ State_____

before starting work. It forms an invisible, non-sticky, unnoticeable film which protects the skin from the action of chemicals, solvents, grease, oil, gasoline, and other substances harmful to the skin. When the hands are washed at noontime and night, the film comes off easily, bringing with it all the dirt, grease, paint, lacquer, etc., that the hands have picked up, and leaving them smooth and clean without the use of abrasives.

The No. 2 cream is applied after finishing work for the day. It replaces the natural oils of the skin with a soothing cream which keeps the hands soft and free from chapping and cracking. This cream is also used by those whose hands are constantly wet with water, since the No. 1 cream is not suited to provide protection against the effects of water and aqueous solutions. Both types of cream are supplied in 16-ounce cans.

Reversible Ratchet Handle

BONNEY FORGE & TOOL WORKS

Bonney Forge & Tool Works, Allentown, Pennsylvania, has announced the addition to its line of a new reversible ratchet handle for ⅜-inch square drive sockets and attachments, to be known as No. T35.

It is light in weight, strong and perfectly balanced. In order to keep out all dust, dirt, grit and grease the ratchet has been fully enclosed.

The ⅜-inch lug makes it adaptable for use with all ⅜-inch square drive sockets and attachments. On the other side of the head is a ¼-inch square opening for use with ¼-inch adaptors or for use on small compressors, motors, shut-off valves, etc.

Made of Bonney "CV" Chrome-Vanadium Steel, chromium plated and highly polished, it has a round knurled handle which insures a firm, comfortable grip.

It will be a useful addition to the kit of any mechanic who uses ⅜-inch square drive sockets.

Recording Chart Ink

PERMOCHART COMPANY

Permochart Company, Koppers Building, Pittsburgh, Pa., announces development of a new recording chart ink after more than six months of laboratory research, especially for use on the renewable permanent recording charts manufactured by this company.

Tests of the new ink are reported to have proven its superiority to ordinary recording ink for this purpose, in several important respects.

Advantages claimed for the new ink are that it starts flowing instantly and easily but does not flood; that it will not cake on the pens even if they run dry and are left so for several days; that it dries quickly and does not smudge or spread. Records of 50 hours duration or more have been made from one filling of the pen.

Permochart Recording Chart Ink is made in three colors; purple, red and green, the first being recommended by the manufacturer as giving the best contrast with the natural color of the Permochart. It is available in 2- and 8-ounce bottles.

The smooth, hard, non-absorbing surface of the Permochart, according to the manufacturer, provides a perfect writing surface for the pen, from which the new ink flows in a uniformly sharp, clear line, insuring easy and accurate readings.

Iron Body Globe and Angle Valves

CRANE COMPANY

Crane Company, Chicago, Illinois, is offering a new line of iron body globe and angle valves designed to withstand exceptionally severe service. The plug type disc is made of Crane nickel alloy and the body seat ring of Exelloy, a specially heat-treated chromium iron. This combination of metals for seating surfaces has been found by extensive tests to offer excellent resistance to wear, temperature, galling and scoring. In addition, these metals are harder, stronger and tougher than metals ordinarily used in iron valves.

These valves are recommended for 150 pounds steam working pressure and 300 pounds on cold water, oil or gas lines. They are made in sizes ¼- to 3-inch, and also are recommended for throttling service.

The stuffing boxes are fitted with a gland and filled with high-grade packing and may be repacked while under pressure when wide open. These improved iron body valves are identified as 314½-P globe and 316½-P angle.

Avoid the High Cost of DIRTY, WET, OILY STEAM

Keep It Clean and Dry with

COCHRANE ALL-SERVICE SEPARATORS

Dirty, oily, wet steam, air and gases are costly to equipment and production processes. Cochrane All-Service Separators will completely remove moisture and solid entrainment that may be destructive to expensive steam-consuming equipment—turbines, engines, pumps, evaporators, cooking vessels, stills, etc.

Cochrane Separators assure complete purification due to exclusive construction features of the baffles and ports. These produce a direct, unrestricted fall of the entrainment, prevent the purified steam from passing over the drip area and again becoming contaminated, and minimize pressure loss through extra large port areas.

More than 10,000 plants in every industry have definitely demonstrated the exceptional service and economy of Cochrane Separators.

Write for full information on the construction and performance of Cochrane All-Service Separators.

COCHRANE CORPORATION • 3115 N. 17th STREET • PHILADELPHIA, PA.

COCHRANE

VALVES • TRAPS • SEPARATORS • SPECIALTIES

ROTO JUNIOR
TUBE CLEANER
CLEANS SMALL TUBES MORE ECONOMICALLY
Up to 200 Tubes Cleaned With One Set of Replaceable Blades
WRITE FOR NEW CATALOG
The ROTO Company
145 Sussex Ave., Newark, N. J.

OCECO Flame Arrestors

Can you afford less positive PROTECTION?

No tight tank protected with an Oceco flame arrestor has ever been lost by fire.

• More than 250,000,000 bbls. of tankage are protected with Oceco flame arrestors. They have Underwriters' approval.. and vertical straight through passages that minimize entrainment.

Oceco flame arrestors are the recognized standard throughout the industry. They are furnished as single units or complete with an Oceco vent valve. Sizes to meet any requirement.

Write for descriptive literature.

U. S. Pat. No. 1,735,261

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Specify

OCECO FITTINGS

your tanks deserve the best

OCECO Fittings

THE JOHNSTON & JENNINGS CO.

OCECO DIVISION

885 Addison Road • Cleveland, Ohio

Engineering and Sales Services: NEW YORK • CHICAGO • PITTSBURGH, BEAUMONT, TEXAS • TULSA, OKLAHOMA • LOS ANGELES • OAKLAND, CALIF.

NATIONAL AIROIL BURNER COMPANY

ESTABLISHED 1912 INCORPORATED 1917

Manufacturers
Installation
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Sales - Service

Industrial Oil Burners Gas Burners and Furnace Equipment

NATIONAL AIROIL BURNER

NAIROIL Automatic Oil Burners for HOMES APARTMENT HOUSES CHURCHES, STORES FACTORY BUILDINGS OFFICE BUILDINGS

Specializing in Equipment for

CHEMICAL MANUFACTURERS
GLASS, CERAMIC & REFRACTORY MANUFACTURERS
METALLURGICAL INDUSTRIES
DOMESTIC AND INTER-COASTAL STEAM VESSELS
PETROLEUM REFINING AND RELATED INDUSTRIES
SUGAR MANUFACTURERS AND REFINERS
PUBLIC SERVICE POWER PLANTS
FACTORY POWER AND HEATING PLANTS
AUXILIARY OIL BURNERS FOR POWDERED COAL PLANTS

Offices and Salesrooms 1327 Girard Avenue

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Philadelphia, Pa.

Swing

INTO BOOTHS NUMBER 26-27

REFINERS & MARKETERS BLDG.

"POP" ATKINS

"HERB" MALAND

"SLATS" LOVE

WILL GIVE YOU A GOOD WELCOME AND TELL YOU ANYTHING YOU WANT TO KNOW ABOUT:

BALL BEARING SWING JOINTS (HIGH AND LOW PRESSURE), METAL HOSES THAT ARE FLEXIBLE AND SAFE FOR EVERY PURPOSE, CIRCULATING HEADS, MUD MIXING GUN!

Chiksan

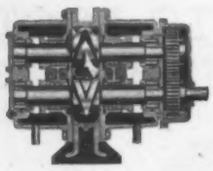
CHIKSAN OIL TOOL CO. LIMITED

FULLERTON, CALIFORNIA - SHELL BUILDING, HOUSTON, TEXAS

KINNEY

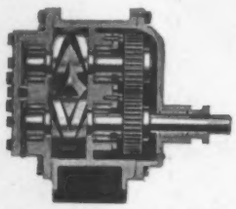
What do YOU want to pump in your refinery?

There are Kinney Pumps operating successfully at 50°, and others at 700°; some are pumping still bottoms, others distillate; some of the smallest discharge 1 g.p.m., some of the largest—3500 g.p.m.; some operate at low pressures, others at 400 lbs. per sq. in. SO, just write us the details and we will recommend the correct pump for your particular job.



Model A Heliquad, External Bearings

Model A Heliquad, with external bearings and timing gears, is a general service pump handling all kinds of liquids, with or without lubricating qualities; cold or hot; viscous or non-viscous.



Model B Heliquad, Internal Bearings

Model B Heliquad pumps are offered for handling liquids possessing some lubricating value as internal bearings and timing gears operate in direct contact with the fluid pumped.

Model G Heliquad, Overhung Bearings

Model G Heliquad, a modification of Model A, has all bearings and timing gears on drive side and rotors overhung; capable of handling the same materials as Model A but designed for low pressures.

KINNEY MANUFACTURING CO.

3539 WASHINGTON ST., BOSTON, MASS.

NEW YORK: 30 Church Street
CHICAGO: 1202 Buckingham Bldg.
DALLAS: 808 Santa Fe Bldg.
PHILADELPHIA: 725 Commercial Trust Bldg.
LOS ANGELES: 1333 Santa Fe Avenue

PUMPS

▼ BUSINESS NOTES ▼

AT THE annual meeting of Revere Copper and Brass Incorporated, Rollo E. Falk, vice president and general manufacturing manager was elected a director. Falk has been manufacturing manager since 1932, and previously was works manager of the Dallas division, in Chicago, Illinois. His headquarters are in New York.

THE Harnischfeger Corporation of Milwaukee, announces appointment of H. S. Strouse as vice president. Along with the duties of his new position, Strouse will continue to direct the activities of the treasurer's department which he has headed for the past seven years.

AN ENLARGEMENT of the current program of research of Gasoline Products Company, and its other activities was announced recently by W. H. Sullivan, newly elected president of the corporation. Sullivan, formerly vice president and treasurer, succeeds William F. Moore, who resigned on February 15 after several years as president to accept an executive position with The Texas Company.

Sullivan, in discussing the value of research and the business prospects of Gasoline Products Company, outlined the history of the corporation from the licensing of the first commercial unit prior to 1921, and referred to the evolution of the small Cross unit into the large combination units of the present day. This evolution was made possible by the early acquisition by Gasoline Products of licensing rights for the Holmes-Manley, Tube and Tank, and other processes, from which modern combination units have been developed. He pointed out that Gasoline Products Company has pioneered numerous advances in cracking, including the multifunction operations represented in both large and small combination units, as well as numerous individual developments. This has been the result of the constant pursuit of research in the laboratory and on a commercial scale, to meet the changing yield and quality requirements of the industry. Although technical progress in the past 10 years has been great, the constant pressure on the refiner for operating economies, yield flexibility and product quality continues. New requirements are arising and the company has doubled its research program in order to anticipate them. Research is being focused particularly on possibilities of increasing octane number of gasoline and yield of satisfactory distillate fuels beyond present levels.

Sullivan stated that the company is hopeful that the new developments for the benefit of its licensees will result from the increased research program, which is carried on in the laboratories of its licensing agent, The M. W. Kellogg Company. No reduction of activities in connection with licensing of present processes is, however, contemplated.

Other personnel changes in the corporation were also announced. Pike H. Sullivan was recently elected vice president of Gasoline Products Company. He was formerly secretary and patent attorney. E. F. Liebrecht was elected secretary and will function as general patent attorney.

W. H. Sullivan first started in the oil

Bachrach

W. H. SULLIVAN
President, Gasoline Products Company

For Pumps Handling
BUTANE, NAPHTHAS and all Light Stocks
USE

PELRO

A packing especially designed for pumps in the oil industry.

Does not contain glycerine in its lubricating compound.

Does not get hard and avoids overheating and friction on the pump shaft.

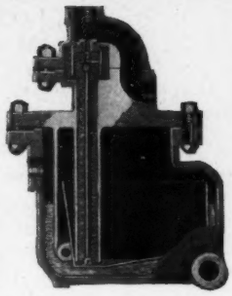
Write for Complete A B C Packing Chart

Send for free working sample. State size.

GREENE, TWEED & CO.
Sole Manufacturers
109 DUANE STREET, NEW YORK

PIPEWRENCH PETE SAYS:

DIVIDE YOUR TRAP MAINTENANCE BY 8!



When the STRONG trap people developed a new kind of metal for valves and seats, they upset all old ideas about trap upkeep. The new ANUMETL lasts EIGHT times longer than even Strong's former wear-resisting metal!

If you aren't using STRONG traps, here's your chance! Get one for your toughest job. Use it 3 months. If it doesn't meet your highest expectations, return it and get your money back, PLUS FREIGHT! Fair enough? Then order it now!

P. S.—STRONG traps made for any liquid—oil, gasoline, etc.

FREE—EASY METHOD OF SIZING STEAM TRAPS.
SEND FOR CATALOG 63-R-1

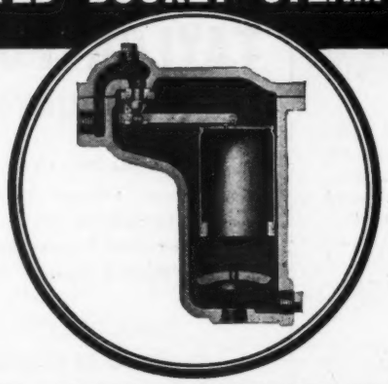
STRONG

QUALITY STEAM SPECIALTIES

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, Ohio

CRYER

INVERTED BUCKET STEAM TRAP



BUILT FOR REFINERY NEEDS

CRYER INVERTED BUCKET STEAM TRAPS are designed to meet the rigid requirements of refinery operation. Install them wherever condensation drainage is involved—in the pump house, on evaporators, on reboilers, in the compounding house, on the steam stills for bright stock, in the sweat pan house, or in the lubricating agitators. You'll soon see the result—fuel consumption is lowered and production is increased.

Six standard sizes to meet all pressure requirements. Write for bulletin and trial offer.

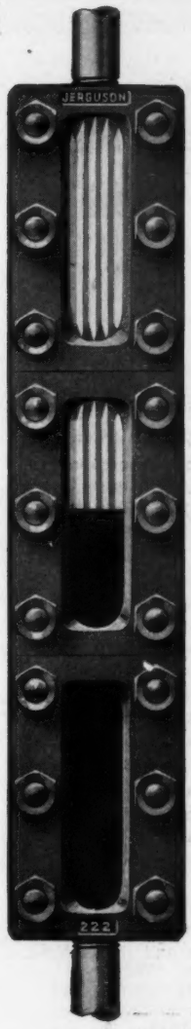
CRYER TRAP & VALVE CO., Inc.
366 MADISON AVE. NEW YORK

JERGUSON

REFLEX GAGES

Year in, year out Jerguson has served the industry, supplying these accurate, dependable gages for steam boilers and for indicating liquid levels in tanks, towers, stills, etc. Every oil man knows—

The *empty* space appears WHITE



The *liquid* shows BLACK

Safe and dependable at all temperatures and pressures. Furnished with or without valves for every type of service. Full information upon request.

JERGUSON GAGE & VALVE CO.
87 FELLSWAY
SOMERVILLE, MASS.

All is not "Best" that's "Better"

THE mere fact that welded pipe installations have proved better than mechanically joined piping, should not obscure the fact that this better way also has its "good, better and best."

If a welded installation were sawed in half, this distinction would become immediately apparent. If it were an installation in which WeldELLS and other Taylor Forge Welding Fittings were used it would look like the unretouched photograph shown above—sound and uniform from end to end—because any qualified welder can make ideal welds when he uses these fittings which have tangents, machine-tool bevelled ends, accurate dimensions, selective reinforcement, and other features not combined in other welding fittings.

So the very reason for welding is the reason for standardizing on WeldELLS—because they represent *this better way at its best.* And of almost equal importance is the fact that the Taylor Forge line is *the most complete* made. It embraces the widest range of types—the widest range of sizes and thicknesses.

Large stocks of Taylor WeldELLS and other seamless steel welding fittings are carried by distributors serving every branch of the oil industry. Ask for WeldELLS.

TAYLOR FORGE & PIPE WORKS

General Offices and Works:
Chicago, P. O. Box 485
New York Office: 50 Church Street

TAYLOR FORGE
WeldELLS
Seamless Pipe Fittings for Welding

business with The Texas Company in 1920. He resigned in 1930 to accept the position of secretary and treasurer of Gasoline Products Company. He also recently was elected president of Process Management Company.

MINE Safety Appliances Company, Pittsburgh, has announced the removal of its Houston, Texas, office to 1718 Louisiana Street. George J. Gruber is district manager.

THE Gasoline Products Company, Inc., announces removal of its offices from Newark, to 26 Journal Square, Jersey City, N. J., and the Gray Processes Corporation likewise announces removal of its offices to the new address above.

PROFESSOR Vladimir N. Ipatieff, director of chemical research, Universal Oil Products Company, has been appointed to represent Northwestern University at the Tenth Annual Congress of Chemistry, to be held in Rome, May 16.

THE Walworth Company has assigned E. L. (Salty) Clark to take charge of the Arkansas-Louisiana-East Texas sales district, including the Louisiana Gulf Coast, according to an announcement from Fred W. Duemler, vice president of the company at Dallas, Texas. Clark has moved from Houston to his new territory with headquarters at Shreveport, Louisiana.

THE Sheffler-Gross Company, Drexel Building, Philadelphia, has been appointed representatives for Eastern Pennsylvania by the American District Steam Company, North Tonawanda, New York.

NEW YORK Belting & Packing Company, Passaic, New Jersey, has announced the recent appointment of Wylie-Stewart Machinery Co., Inc., 1400 Exchange Avenue, Oklahoma City, as distributor of the company's line of mechanical rubber goods in the Oklahoma City territory.

J. F. LINCOLN, president of The Lincoln Electric Company, Cleveland, Ohio, announces establishment of a manufacturing subsidiary to be called Lincoln Electric Company (Australia) Ptv., Ltd., at Sydney, Australia. A suitable factory has already been purchased and arc welding equipment manufacturing operations will begin in a year's time.

While in Australia, Lincoln visited all the capital cities, giving a series of addresses before various engineering societies and groups on developments in the art of welding. He is expected back in the United States in May, returning by way of South Africa and England in both of which countries the Lincoln company has holdings.

THE Cochrane Corporation, Philadelphia, announces the appointment of C. J. Gaskell Company, 1011 Falls Building, Memphis, Tennessee, as district representative for all of its products in Arkansas, Western Tennessee and Northern Mississippi.

PETROLEUM Rectifying Company of California announces the appointment of William Woelflin as California district manager with headquarters at the company's offices in Long Beach, California.

Woelflin has been with Petreco for 12 years, serving in various phases of the company's research and development activities as research engineer in the laboratory at Long Beach, and the past two years as California district engineer.

WILLIAM WOELFLIN

A graduate of the University of Cincinnati with the degree of chemical engineer; and a member of Tau Beta Pi, honorary engineering society, Woelflin entered the oil business on leaving school and since then has had considerable experience in both the production and refining departments.

APPLICATION for membership in the Cooper & Brass Research Association was made recently by the Riverside Metal Company, Riverside, New Jersey, and The Sevmour Manufacturing Company, Seymour, Connecticut. These applications will be accepted at the next meeting of the board of directors, and in the meantime both companies will be accorded full membership privileges.

Riverside Metal Company manufactures and distributes nickel silver, phos-

CALL US

for the following

TAYLOR FORGE
PRODUCTS

Flanges, Weldells, Welding Reducers, Welding Tees, Flanged Unions, Special Flanges, Orifice Flange Unions, Boiler Nozzles, Welding Neck Nozzles, Spiral Welded and Spiral Riveted Pipe.

PRINCIPAL ITEMS
STOCKED IN HOUSTON

THE CORBETT-WALLACE CORPORATION

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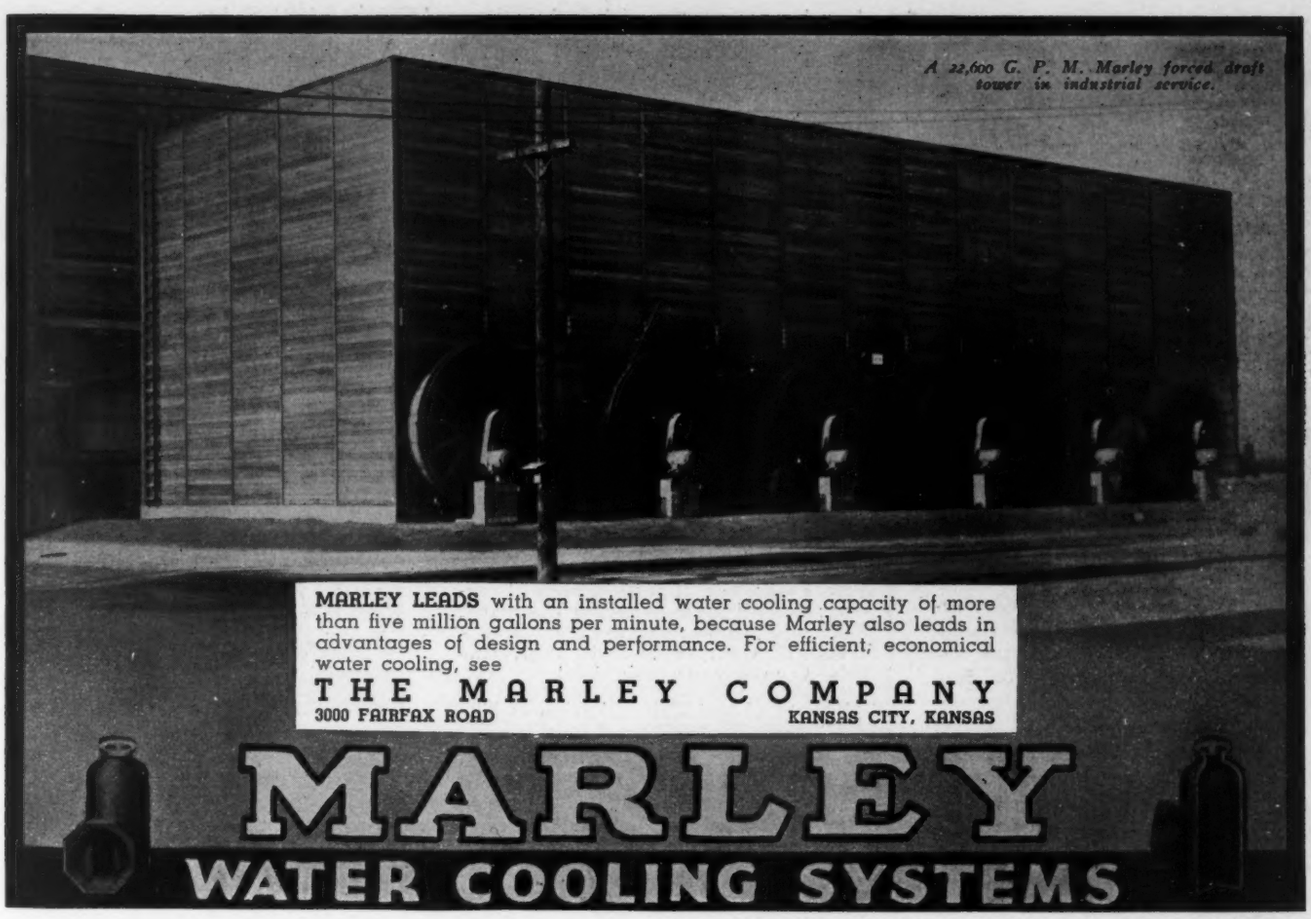
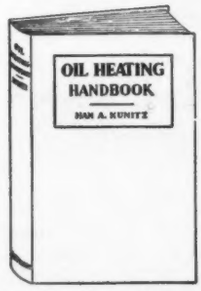

A 22,600 G. P. M. Marley forced draft tower in industrial service.
MARLEY LEADS with an installed water cooling capacity of more than five million gallons per minute, because Marley also leads in advantages of design and performance. For efficient, economical water cooling, see
THE MARLEY COMPANY
3000 FAIRFAX ROAD
KANSAS CITY, KANSAS
MARLEY
WATER COOLING SYSTEMS

OIL HEATING HANDBOOK

By HAN A. KUNITZ



This all-inclusive treatise is absolutely essential to all who manufacture, distribute, install or use modern heating methods. After months of unremitting efforts, Han A. Kunitz, widely known authority on oil heating in the domestic and industrial field, has written the first book of its kind. In it every question about oil heating is answered; the principles, installation and maintenance, explained thoroughly and impartially; and every word used in connection with heating engineering is concisely defined. This is THE key to a wider and better understanding of the principles of heating and oil burners. Contents: A Step Ahead; The Oil Burner System; Oil, Flame and Combustion; Petroleum Fuel; Flame and Ignition; Combustion and Efficiency; Heat and Radiation; Testing Oil; Technical Aspects of Oil Burner Flame; Combustion Technique; Heat and Heating; Heating for Comfort; Heating Principles and Calculations; Heating Systems; Warm Air Heating; Controls; Installation and Service; Survey and Installation; Charts; Service; Sound and Noise; Retail Selling; To the Manager of Retail Sales; To the Salesman; Terminology, Tables and Statistics, Weather Chart, Etc., Index.

CONTAINS 465 PAGES and many Tables, Diagrams and Charts . . . PRICE $3.50 Postpaid.

GULF PUBLISHING COMPANY
P. O. Box 2811, Houston, Texas

WATEROUS HEAVY DUTY ROTARY PUMPS

Hardened steel pilot gears, anti-friction outboard bearings, large shafts with screwed-on protecting Ni-Resist sleeves, smooth and quiet operation, result in a pump that is capable of continuous service over long periods of time. Inquiries will receive prompt attention.

WATEROUS COMPANY
St. Paul, Minnesota
Established 1886

Yet there's No Damage

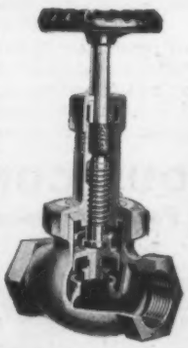
A smashing blow with a hammer won't injure Fairbanks Asbestos Disc Rings—a more severe test than any ring gets in service. They withstand brutal punishment that would disintegrate ordinary rings because they are reinforced with genuine long-fibred asbestos.

Another thing which prolongs the life of these rings is the design of the Fairbanks Disc Nut which throttles the action of the stream against the disc.

Fairbanks Disc Rings give equally long and efficient service with steam, hot water or cold water, eliminating the necessity of stocking several types.

The slide-on disc holder drops off when valve is taken apart, making it easy to change the disc. Perfect alignment is assured by the radial seat between body and bonnet when the valve is assembled.

Stuffing box can be packed under pressure without danger of leakage because the seat is above the threads on stem where no sediment or foreign matter can reach and pit or score the seating surfaces or prevent tight closing.



Write for Catalog No. 21 describing our complete line of bronze and iron valves.

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20 East 4th St. New York, N. Y.

Valves, Dart Unions, Hand Trucks and Wheelbarrows

Boston—Pittsburgh
Distributors in Principal Cities
Factories: Rome, Ga.; Binghamton, N. Y.

Fairbanks Renewable Valves

phor bronze, cupro nickel, beryllium copper, brass, commercial bronze, Guinea gold alloy, and shot copper; sheets, rolls, strips and plates; circles and blanks; wire and rods, bars.

Seymour Manufacturing Company manufactures nickel silver, phosphor bronze, brass products, cupro nickel, and nickel anodes.

The membership of the Copper & Brass Research Association now represents the following companies which manufacture almost 95 percent of the products fabricated from copper and its alloys:

The American Brass Company, Waterbury, Conn.; Bridgeport Brass Company, Bridgeport, Conn.; Chase Brass & Copper Co., Incorporated, Waterbury, Conn.; C. G. Hussey & Company, Pittsburgh, Pa.; Mueller Brass Co., Port Huron, Mich.; National Brass & Copper Company, Inc., Lisbon, Ohio; The New Haven Copper Co., Seymour, Conn.; Phelps Dodge Copper Products Corporation, New York; Revere Copper and Brass Incorporated, New York; The Riverside Metal Company; Scovill Manufacturing Company, Waterbury, Conn.; The Seymour Manufacturing Company; and Wolverine Tube Company, Detroit, Mich.

THE Steel and Tube Division of The Timken Roller Bearing Company has appointed Joseph T. Ryerson & Son, Inc., to warehouse Timken Mechanical Tubing (S.A.E. 1015 Steel) in territories served by Boston, Jersey City, Philadelphia, Buffalo, Cincinnati, Chicago, St. Louis, Cleveland, Detroit and Milwaukee.

During the last few years a large demand has developed for Timken's high-grade mechanical stocks. Because of the fact that production is geared up for large runs, it has been impossible to keep pace with this demand. With the Ryerson Company's warehouses now carrying a complete stock of Timken mechanical tubing, this quality product is now available for immediate shipment.

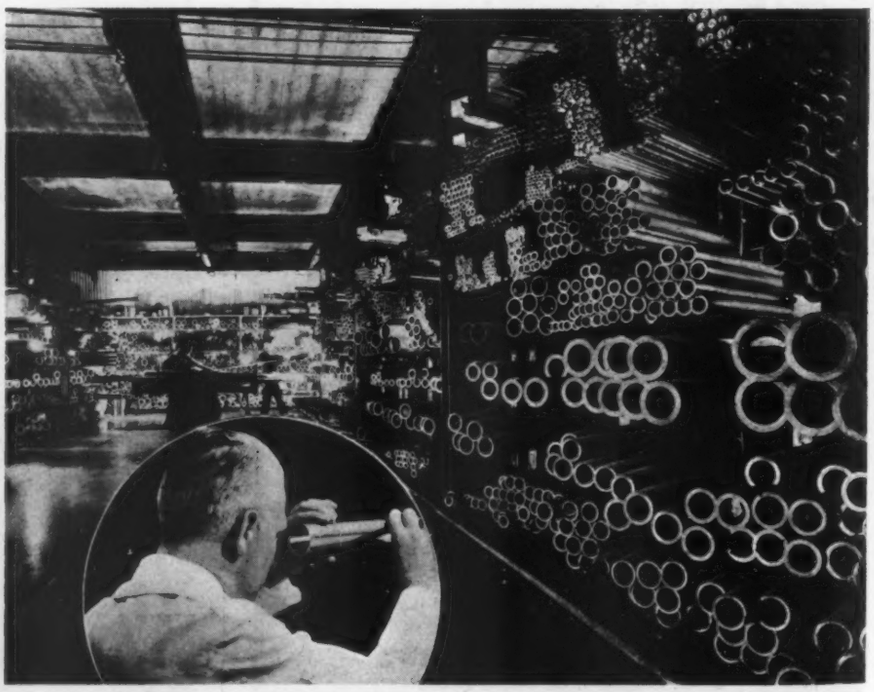
TUBE-TURNS, Incorporated, Louisville, Kentucky, announces that W. B. Whenthoff has joined the company's sales organization as district manager for the Mid-Continent district. Whenthoff was formerly with the Big Three Welding & Equipment Company of Tulsa, where in his new connection he will maintain headquarters. Whenthoff has had wide experience in welding

W. B. WHENTHOFF
Now with Tube Turns

operations of all kinds and is well qualified to discuss welding problems in connection with piping construction and design.

THREE vice presidents and two division managers of Westinghouse Electric and Manufacturing Company have been assigned new duties in a revised schedule of responsibilities announced by President George H. Bucher.

Vice President Ralph Kelly is placed in charge of sales of the company with



Stock of Timken Steel tubes carried by Joseph T. Ryerson & Sons

THE SAFE CHOICE *for any* HOSE MASK JOB

The M.S.A. Combination Hose Mask is the most efficient means of supplying *fresh air* to men working in dangerous atmospheres. It is ideal equipment wherever maintenance, repair or cleaning operations around refineries, tanks or gas-holders, etc. require men to work in confined spaces where there may be either high concentrations of gas, or oxygen-lacking atmospheres. • Comfortable and durable, designed for unencumbered working ease, this U. S. Bureau of Mines-approved Hose Mask supplies more than enough air for 2 men with as much as 150 feet of hose to each mask. *Demonstrations arranged on request.*

MINE SAFETY APPLIANCES COMPANY

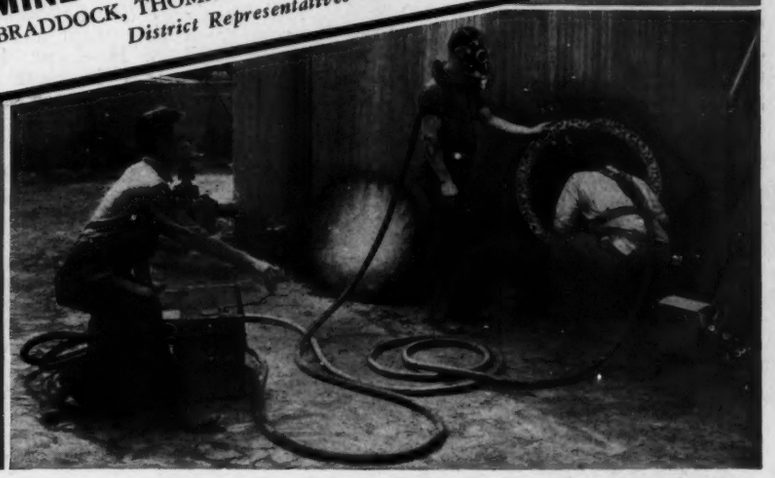
BRADDOCK, THOMAS and MEADE STREETS, PITTSBURGH, PA.

District Representatives in Principal Cities

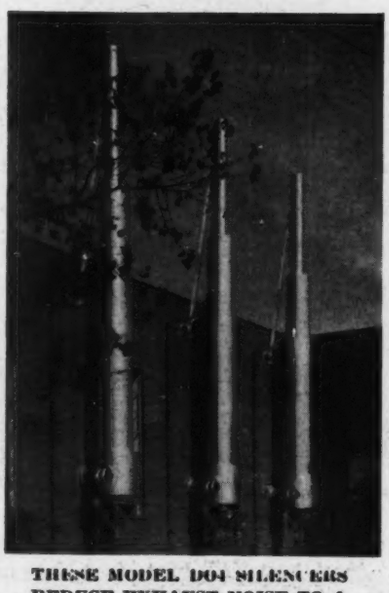
M·S·A

COMBINATION HOSE MASK

OFFICIALLY APPROVED BY THE U.S. BUREAU OF MINES AND AMERICAN GAS ASSOCIATION



MAXIM SILENCERS INVADE *the* OIL FIELDS

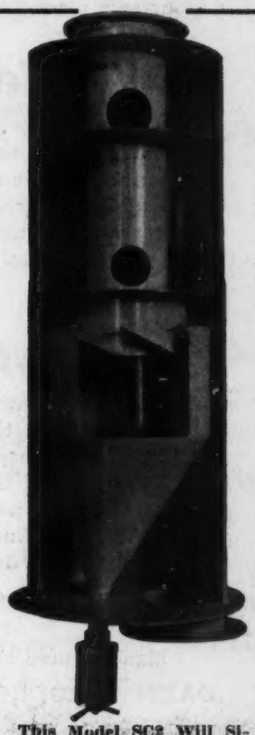


THESE MODEL 104 SILENCERS REDUCE EXHAUST NOISE TO A WHISPER

Wherever you find engines, you will find MAXIM SILENCERS. A wide variety of models permits selection of *exactly* the correct type for your engine, compressor, blower or vacuum pump. Also, *heavy duty* exhaust silencers are available for natural gas engine application.

See Maxim Silencers in operation at the Tulsa Oil Show at the following booths:

COOPER-BESSEMER CORPORATION
HAPPY BELTING COMPANY
FRANK MANUFACTURING COMPANY
LUFKIN COMPANY
WAUKESHA ENGINE COMPANY



This Model SC2 Will Silence Your Exhaust, at the Same Time Trap all Sparks

THE MAXIM SILENCER COMPANY

HARTFORD, CONN. DALLAS, TEXAS

HOT
FLOW-ON
METHOD
Makes
Storage Tank
PAINT
STRIPPING
Easy
Safe
Fast

Easy

Make up a solution of the recommended Oakite material. Apply by Oakite Flow-On Method. Automatically, completely covers surfaces. Use inexpensive equipment easily made up in your own plant.

Safe

Non-inflammable . . . used in water solutions, Oakite materials are safe to handle and apply. They cause no objectionable fumes. No chipping or abrasive methods needed.

Fast

Large areas of surfaces are stripped at one time with this Oakite method. Important to you, too, is the low cost of Oakite paint-stripping. Write for interesting, free four page descriptive folder.

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Certified cleaning
MATERIALS & METHODS FOR EVERY-CLEANING REQUIREMENT

headquarters in the Pittsburgh executive offices. Formerly he was in charge of Pittsburgh district works including the headquarters plant at East Pittsburgh.

Vice President R. B. Mildon assumes management of the East Pittsburgh division coming here from Philadelphia where he had charge of the steam and stoker departments with headquarters in the South Philadelphia Works. His new offices will be in East Pittsburgh.

Vice President N. G. Symonds, long associated with sales operations, will devote his time in the sales department to specific customer activities, association work and special duties as assigned.

Other appointments listed Roy A. McCarty, formerly manager of the small motor division at Lima, Ohio, as transferred to South Philadelphia as manager of the steam and stoker division; and B. H. Lytle, formerly a division manager in East Pittsburgh goes to Lima as manager there.

MANNING, Maxwell & Moore, Inc., with plants in Bridgeport, Boston, Muskegon and Jersey City, recently struck a new note in "industrial democracy." In a local auditorium the thousand-odd employes heard their president, Robert R. Wason, present a detailed report covering the company's operations during the past year.

All facts were presented with complete frankness. With some 60 animated lantern slides, Wason went into every phase of the operations of the company, which does an annual volume of approximately ten million dollars in the production and sale of industrial equipment including gauges, valves, locomotive and railway equipment, cranes and hoists, precision instruments and mill supplies.

Every employe was informed of the most intimate details of just what happened to each penny of every sales dollar received. He told how much was spent for materials, wages, salaries and profits, and how much of the profits had in turn been reinvested in the plant and equipment. Wason stated that the men and women who work for a business have just as much right to know these confidential facts as the stockholders who have their money invested in it.

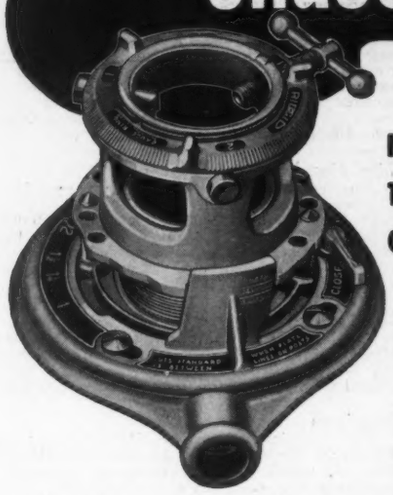
It was brought out that approximately 84 percent of the company's income in 1937 came from new products developed by the company since 1932, pointing out in this connection that constant study of the needs of the market, together with the necessary engineering development to adapt products to meet changing needs, had made it possible not only to maintain employment, but also to provide more jobs for more people.

Another innovation in this meeting was the distribution of slips and pencils and the invitation that any and all questions be asked. At the close of the talk, Wason, frankly answered each question.

In conclusion, speaking on general conditions, Wason said he felt that the business outlook was inherently by no means as dark as it is sometimes painted. "What business needs today is a chance to settle down and go to work," he said.

More than 1,000 lineal feet of welding was required to fabricate this absorber designed for use in treating oil. It is 8 feet in diameter at the bottom, 7 feet in diameter at the top and 58 feet 10 inches high. The 1 1/16-inch flanged No. A-70 steel bottom section required 10 beads of welding. The 15/16-inch flanged No. A-70 steel top required 8 beads in all roundabout and vertical seams. The vessel has 26 flanges or manholes varying in size from 8 to 24 inches and was fabricated by the Tulsa Boiler and Machine Company with Westinghouse FlexArc welders.

STOP *the bother of changing* Chaser Dies



RIDGID

No. 65R Threads 1" to 2" Pipe with ONE Set of Chasers

Instead of 16 chaser dies to lug around, to risk losing, to waste valuable time changing every time you want to thread different size pipe, this threader has only 4 — and they stay in the threader.

A quick shift of the setting post and you're ready to cut perfect threads on 1", 1¼", 1½" or 2" pipe, any metal — over or under size, drip threads or short nipples — a convenience that runs into real money saving.

Like many thousands of users, you go for the new style work-holder that clicks to pipe size with a twist of the gauge ring and tightens with one screw. No bushings to bother with.

Plenty of other efficiency features in this rugged modern threader. The more experienced a judge of pipe tools you are, the more satisfaction you get out of owning and using this RIDGID No. 65R. Try one at your Supply House — buy it for better, faster, easier threading.

RIDGID No. 65R has feet which make it stand up conveniently on the floor.
No. 85R, 2-handle ratchet die.
No. 65, 2-handle plain die.

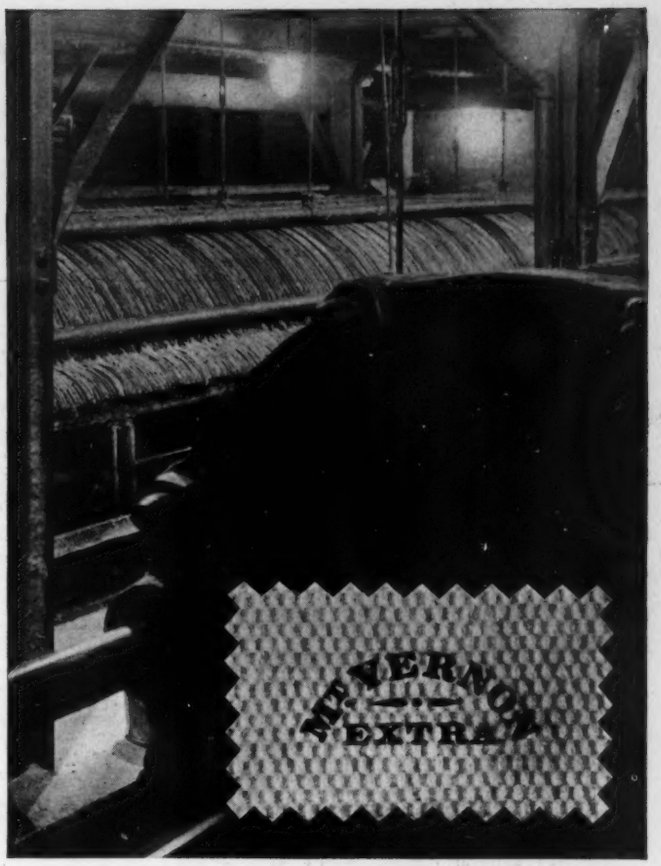
THE RIDGE TOOL CO., ELYRIA, O.

RIDGID Practically Stops Pipe Wrench Repair Expense

Save 75% of what it's been costing you for wrenches on the sick list and repairs — by buying RIDGIDs. Ask your Supply House.

RIDGID PIPE TOOLS

Stop in and see our BOOTHS Nos. 28, 29, 30, in the Texas Bldg., at the OIL SHOW, Tulsa, Okla., May 14-21



Filtering for Profit with (MT. VERNON EXTRA) Precision Filter Fabrics

Any slight increase in efficiency can often vitally affect the profit factor in any filtering operation. From a filter fabric point of view once the right construction has been chosen the degree of efficiency then rests squarely upon the uniformity of the fabric used . . . uniformity of yarn . . . uniformity of weave.

MT. VERNON EXTRA filter fabrics are woven on the finest modern looms and tested to rigorous standards of tolerance. They are really precision fabrics.

Specify MT. VERNON EXTRA for that last ounce of filtering efficiency.

MT. VERNON-WOODBERRY MILLS, INC.
TURNER HALSEY COMPANY
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CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Insulation Materials

The Eagle-Picher Sales Company, Temple Bar Building, Cincinnati, Ohio, has published a new, illustrated, 40-page catalog dealing with that company's insulation materials, under the title "Eagle Picher Insulation." The catalog discusses and illustrates fill materials, flat materials, pipe insulations and plastic insulation, and presents a section of reference tables.

Boiler Regulation

The Brown Instrument Company, Philadelphia, has published Catalog No. 5001, Brown Automatic Boiler Regulation, which includes descriptions of the steam damper regulator, overfire control, control valves, and various accessories.

Thermometer

The Foxboro Company, Foxboro, Mass., has published a new Thermometer Bulletin, No. 198-1, which is as free from technicalities and as interesting in arrangement as it is possible to make such a subject. Complete information on each available type of thermometer, recording and otherwise, is given and the catalog is well illustrated with drawings and photographs.

Equipment

The Patterson Foundry & Machine Company, East Liverpool, Ohio, has published new literature "Patterson Laboratory and Pilot Plant equipment," covering pebble, ball and tube mills, mixers, kettles, autoclaves, filter presses, dry and wet pans and clay and mineral working machinery.

Instruments

The Brown Instrument Company, Philadelphia, has published a new folder entitled "Legibility Plus Precision," which reproduces the colored numeral records, exactly as they are printed on the chart of the Brown potentiometer pyrometer recorders. It explains the significance of the exclusive Brown symbol which is part of the numeral record.

Pyrometers

C. J. Tagliabue Manufacturing Company, Park and Nostrand Avenues, Brooklyn, N. Y., is distributing a new 28-page pyrometer catalog, No. 110D. This book describes and illustrates many features of the Tag Celectray indicating, recording and controlling pyrometers and resistance thermometers, which utilize a phototube, mirror galvanometer and a beam of light. This construction offers instantaneous action, accuracy of 0.1 percent and high sensitivity, it is said. Large illustrations show the mechanisms of various models.

Glass

The United States Glass Company, Ninth and Bingham Streets, Pittsburgh, has published a new illustrated brochure, describing its facilities for the engineering and manufacture of glass for industrial and commercial purposes.

Hose

Manhattan Rubber Manufacturing Division, Raybestos-Manhattan, Inc., Passaic, N. H., has published a new folder showing a large number of actual and unusual installations of Manhattan and Condor Hose being used in a wide range of industries. It also contains a detailed description of types of construction of the hose, as well as helpful technical data.

Mixers

Mixing Equipment Company, 1034 Garson Avenue, Rochester, N. Y., has published new interesting literature "Plain Mixing Facts for Careful Buyers," which describes in detail a wide range of "Lightning" mixing devices manufactured by this company.

Blow-Off Valves

The Hancock Valve Division, Manning, Maxwell and Moore, Inc., Bridgeport, Conn., is distributing new literature describing the new Hancock Blow-off valve with the blow-deflector seat and disc. Full engineering information is given along with drawings and photographs of the new valve.

Corrosion Control

D. W. Haering & Company, Inc., 3408 Monroe Street, Chicago, has published the second edition of "Organic Methods of Scale and Corrosion Control," a complete technical exposition of the application of organic chemistry in this field. The 16-page booklet discusses and describes underlying principles and applications of organic chemistry. It is illustrated with graphs, formulae and equations of interest to those responsible for scale or corrosion control.

Heaters

Alberger Heater Company, 281 Chicago Street, Buffalo, N. Y., has published a new catalog "Alberger Heaters," which describes the commercial types and gives considerable engineering data, dimensions, etc., having to do with heaters in general. Complete engineering information is presented. Included with the catalog is the Alberger universal alignment chart for determining correct sizes for steam condensate of water heater lines.

Bearings

Shafer Bearing Corporation, 35 East Wacker Drive, Chicago, is distributing a new catalog, No. 14, covering Shafer radia-thrust roller bearings and self-aligning units. The catalog describes a complete line of radial-trust roller bearings and self-aligning ball and roller bearing units for a full range of industrial and machine applications. Price list is included.

Ventilation

The Swartwout Company, Cleveland, Ohio, has published Bulletin No. 205, Catalog Section B, dealing with "Controlled Air Circulation for Industrial and Commercial Buildings." This describes the Swartwout rotary, ball bearing ventilator, and by means of numerous drawings and concise text gives the full story with all pertinent engineering information. A number of typical installations in the petroleum industry are shown by photographs.

Gages

Ashton Valve Company, Cambridge, Mass., is distributing Catalog 38 G covering a wide variety of gages and testing apparatus, including pressure, vacuum, recording gages, pop valves, relief valves, and other equipment.

Condenser Tubes

Condenser Service and Engineering Company, Inc., Hoboken, New Jersey, has published a new technical bulletin dealing with the deterioration and failure of condenser tubes and the extension of the life of tube by the air and erosion eliminator. The purpose of the eliminator is explained and its advantages in longer tube life detailed.

Tile Conduit

American District Steam Company, North Tonawanda, N. Y., has published a revised, 8-page Bulletin, No. 35-67 A on ADSCO-Bannon Tile Conduit and ADSCO-Corning Filler Insulation for underground steam and hot water lines, including illustrations of the products, details of construction and their applications.

Electrodes

Metal & Thermit Corporation, 120 Broadway, New York, has published new literature describing in detail a wide variety of Murex heavy-coated welding electrodes and their applications.

Bearings

The Gwilliam Company, 360 Furman St., Brooklyn, New York, has published Catalog No. 14, which presents destailed information regarding the company's line of roller thrust bearings, ball thrust bearings, journal roller bearings, metal balls, steel rolls and special bearings.

Naphthenates

Nuodex Products Company, Elizabeth, New Jersey, has published new literature dealing with the various mineral naphthenates for extreme pressure lubricants for hypoid gears, produced by this concern. The bulletin deals specifically with Nuodex lead naphthenate solution and gives information as to shipping points and shipping methods.

Weld Fittings

Bonney Forge and Tool Works, Allentown, Pa., has published a new catalog covering Bonney Weldolets and Threadolets, individual stock welding fittings specifically designed to make branch pipe connections such as teas, crosses, side-outlets, and the like by welding. The fittings are fully described and a large number of drawings and photographs show methods of application and utilization by various industries. Complete information is given as to sizes, weights and dimensions for both the Weldolets and Threadolets.

Neoprene

E. I. du Pont de Nemours & Company, Rubbers Chemicals Division, Wilmington, Delaware, is distributing Volume 1, No. 1, of a new publication, "The Neoprene Notebook," in which it is planned to give the engineer and the manufacturer engineering information, laboratory data, and application reports on neoprene.

Pipe

Grinnell Company, Providence, R. I., is distributing its new "Data Book on Pipe Fabrication," a 76-page catalog covering such subjects as prefabricated piping, pipe bends, general pipe data, pipe hangers, safety valve discharge elbows, steel flanged fittings and flanges, lap joints, lap joint nipples and stud bolts. This book supplements the pictorial booklet on Grinnel Prefabrication and contains serviceable information providing for the selection of a single piece of prefabricated material as well as for the laying out of a complete power piping specifications.

Valves

Hancock Valve Division, Manning, Maxwell & Moore, Inc., Bridgeport, Conn., is distributing Bulletin 4-4500, "Hancock 500 Brinell Bronze Valves," which describes this line of valves with the nail-smashing hardened stainless steel seats and discs. All dimensional and pertinent engineering information is included.

Gas Regulators

The Chaplin Fulton Manufacturing Company, Pittsburgh, has published a new catalog, "Fulton Gas Regulators," with the automatic cut-off for natural gas and the Fulton duplex sensitive gas governor for manufactured gas. The 76-page catalog covers the entire line of Fulton regulation equipment, giving full details and

USE THIS COUPON

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MANUFACTURER'S NAME

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MANUFACTURER'S ADDRESS

Please send me, without obligation, free booklet described in May, 1938, issue of REFINER AND NATURAL GASOLINE MANUFACTURER.

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all pertinent engineering information and is well illustrated with photographs and line drawings of the various items discussed.

Level Gages

Penberthy Injector Company, Detroit, Michigan, is distributing a new catalog 33-A, covering its line of "Water and Liquid-Level Gages." Full information is presented covering all types of water-level gages, automatic gages, bronze and iron gages, extra heavy types, drop forged steel gage valves, and Penberthy Reflex liquid level gages, and injectors, drainers and lubricating devices.

Alloys

Bridgeport Brass Company, Bridgeport, Conn., has published a new 80-page technical handbook covering the physical properties and applications of four high strength silicon bronzes pioneered by this company and sold under the trade names of Duronze Alloys. These alloys are recommended for service in outdoor construction where steel, brass and copper are not strong enough to have sufficient corrosion resistance.

Steam Engines

Troy Engine & Machine Company, Troy, Pa., is distributing Bulletin 101, entitled "One Half Cent Per Kilowatt Hour Power Cost." It tells the story of how 43 leading concerns and institutions in 29 different industries cut power costs for driving 19 different types of auxiliaries to an average of one half cent per kilowatt hour. Individual case records are presented giving all cost data. The booklet is well illustrated and includes much engineering data of interest and value.

Insulation

Quigley Company, 56 W. 45th St., New York, issued an 8-page bulletin describing the advantages of Insulbrix in various installations. Insulbrix are light weight low heat storage insulating fire brick which combine the advantage of a high refractory and an efficient insulator of low heat storage capacity. They are used for direct exposure to flames and gases in boiler furnaces, ovens, and other high-temperature equipment. The advantages claimed for Insulbrix are fuel, time, and labor savings, increased production, higher efficiencies and lower operating costs.

Pumps

Goulds Pumps, Inc., Seneca Falls, N. Y., announces in Bulletin 210 a new line of single-stage, side-suction, ball-bearing centrifugal pumps. The bulletin gives complete details, engineering information, data tables covering this line of pumps.

Manometers

The Meriam Company, Cleveland, Ohio, has just issued a revised and enlarged edition of its booklet entitled "The Manometer and Its Uses." Beginning with a description of the elemental principles of manometer operation it continues with an illustrated discussion of the various types of manometers and their use for special industrial applications. The book also contains conversion tables for various indicating fluids, instructions for installations and tables for the measurement of open flows.

Electrical

Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued the following literature: A-67088, "Electrical Drive Selector and Hints on Maintenance," which describes and illustrates the requirements which must be met in selecting a motor; and A 67207, "Motor Starters Protected Against Explosion and Corrosion," or "Five Point Protection Against Explosion and Corrosion with Westinghouse De-Ion Oil-Immersed Motor Starters."

Equipment

The Duriron Company, Dayton, Ohio, has issued a new bulletin on steam jets, ejectors, tank outlets and spray nozzles. The bulletin is illustrated with photographs and dimension drawings and capacity tables are given where applicable. A copyrighted chart simplifies the selection of the correct size jet for heating any volume liquid with steam pressures varying from 15 to 85 pounds. Steam consumption is automatically computed at the same time.

Alloys

Haynes Stellite Company, Kokomo, Indiana, is distributing a new 36-page booklet, "Hasteloy, High-Strength Alloys for Corrosion Resistance." Points covered in detail are chemical and physical properties, available forms, methods of fabrications, machining and welding, and typical successful applications of the various alloys. Penetration rates are tabulated for a number of highly-corrosive acids and other useful data are presented.

Brake Linings

Johns-Manville, 22 East 40th Street, New York, in a new illustrated brochure, "Industrial Friction Materials," has gathered together comprehensive data on the complete lines of industrial brake linings and blocks and clutch facings which it manufactures for all types of industrial equipment.

Sand Blast Gun

Michiana Products Corporation, Michigan City, Indiana, announce publication of a new four-page pamphlet describing and illustrating the Michiana Sand-Blast Gun. In addition to descriptive details, a series of photographs show various operations, and micro-photographs show the smooth uninjured finish of surfaces cleaned with the sand-blast gun.

Potentiometers

The Bristol Company, Waterbury, Conn., has published Bulletin 507, describing its line of round-chart Pyromaster Potentiometers. The publication describes Pyromaster recorders, recorder-indicators and dial indicators and their simplified operating mechanism. Information is also given regarding these instruments as air-operated controllers using Bristol's free-vane principle in air-control, and as electrically-operated controllers. The latter uses the company's Unitact type control which is applicable only to the pyromaster.

Hygrometers

The Brown Instrument Company has published a new catalog, No. 6502, on Brown Hygrometers which covers the line of recording and controlling hair hygrometers. Both electrically-operated and air-operated humidity controllers are described, including all engineering information pertinent thereto.

Electrically Driven Centrifuges
Hand Centrifuges
WRITE
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Pumps

Aldrich Pump Company, Allentown, Pa., has published the 4th edition of "Hydraulic Tables and Engineering Information Data 50," and Data 41 on high-speed pumps. Both booklets are filled with pertinent pump and pumping engineering data of value to those interested in pumps and their performance.

Mixers

The Patterson Foundry and Machine Company, East Liverpool, Ohio, is distributing new literature of interest and value dealing with Patterson mixers. The booklet is essentially a picture story of a wide variety and types of mixers designed for all mixing problems.

Electrical

General Electric Company, Schenectady, N. Y., has recently released the following literature describing a variety of that company's equipment, Gea-1590C, Oil-immersed Magnetic Switches for Installation in Corrosive Atmospheres; GEA-1423A, Solenoid-Operated Valves; GEA-67E, Float Switches for use with Automatic Pumping Equipments for Water Level Control; GEA-2704, A Full Line of Arc-Welding Accessories; GEA-2776, G-E Gasoline-Engine Driven Arc Welder; GEA-2473, Push Button Stations for use in Control Circuits of Magnetic Controllers; GEA-2635, Reduce Costs with G-E Recording Instruments; GEA-1587C, Combination Magnetic Switch; GEA 2450A, Air Circuit Breakers; GEA 1438A, Automatic Telemetering Equipment; and GEA-2711, Type HEA Multicontact Auxiliary Relays for Six to Ten Circuits.

Vapor Pressure

Industrial Engineers, Inc., 818-A East 59th St., Los Angeles, is distributing a new Bulletin No. 2, "Graphical Vapor Pressure," which discusses from both technical and practical standpoint the problem of recorded vapor pressure and its solution. The bulletin discusses the importance of vapor pressure recording, describes the industrial vapor pressure recording instrument, its design, construction, operation, maintenance, accuracy and costs and gives list of users. Typical installation photographs are used and line drawings illustrate the device and its use.

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